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CITY COUNTY STATE
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Des Moines Infiltration Galleries

Supply satisfactory in both quantity and quality obtained during forty years from galleries drawing from river, supplemented by water pumped upon nearby lands and seeping to the galleries.

The Des Moines water supply is of special interest to waterworks men because it has for fifty years utilized a source of supply seldom successfully employed. The water has been and continues to be obtained through a system of collecting galleries which are fed almost entirely by infiltration from a river which runs roughly parallel to the gallery system and about 150 to 200 feet from it.

The present population of Des Moines is approximately 145,000, which it has reached by a comparatively uniform rate of growth from 11,000 in 1870, when the waterworks was built. During the year 1923 the average rate of pumpage was 11.8 m.g.d., the maximum 8-hour rate was 19 m.g.d. and the estimated peak for domestic requirements and fire protection is 26 m.g.d.

The water is pumped from the gallery system directly into the city mains without storage or secondary pumping. The gallery system is able to supply the peak rate indicated above.

The pumping station and gallery system are located on the Racoon river, which has a minimum flow of 50 to 100 second feet. The surface soil is heavy clay. The character of the underlying rocks has no significance so far as this supply is concerned. At this point the ancient valley of the Racoon river is about 1 mile wide, the bottom and sides of the ancient channel being formed by impervious clays. As shown by the section, the surface soil is underlaid with several feet of coarse sand.

HISTORY OF THE PLANT

In 1871 the works were built drawing water from a circular well near the river. In 1882 a wooden collecting gallery about 5x4 feet paralleling the river was built and gradually extended until in 1905 about 3,300 feet was in use.

Up to this time it was supposed that the water obtained by the gallery was derived from rainfall without important infiltration of river water. An investigation in 1907, however, showed that in the vicinity of the collecting galleries the ground water level was several feet below the surface of the river; also calculation based on rainfall and the area tributary to the gallery showed that it would furnish less than one-twentieth of the amount being pumped; and it was, therefore, evident that most of the water came from the river. Investigation of this indicated an average filtration rate of 100,000 gallons per acre of riverbed per day in that portion of the river which was apparently feeding the gallery.

Other evidence that the supply was from river infiltration was furnished by the fact that at times of high water the difference in level between the river and the water in the suction well was one foot or less, but at times of low water the difference often reached 5 or 6 feet. Moreover, when the water level in the gallery became so low as to be thought dangerous, it had been the custom to scrape the gravel bars in the river opposite, which had become more or less coated with silt, and this materially increased the amount reaching the gallery.

This study appeared to indicate that the supply could be increased to the maximum desired by drawing further upon the same source of supply. Also the matter of quality of the water was studied, and the conclusion was to extend the gallery system.

A few months ago the firm of Alvord, Burdick & Howson was called upon to report on the supply, and its report was made the basis of a paper by Charles B. Burdick, a member of this firm, before the New England Water Works Association, from which paper this article is abstracted.

These engineers found that, at the end of 1923, 10,144 feet of the collecting gallery was in use, including the 3,319 feet built originally. The new gallery consists of reinforced concrete rings or tiles 4 feet in diameter, 2 feet long and 2 inches thick, laid on timber cradles to insure alignment, with a ¼-inch space between rings made uniform by four lugs cast on each ring. After the rings had been placed, the spaces between the rings and the sheeting, and above and below the rings, was filled with screened gravel to a thickness of 8 to 12 inches. The trench was then filled with the excavated sand and the sheeting withdrawn This conduit was laid with

the bottom about 14 feet below the low-water surface of the river, necessitating a trench varying from 25 to 35 feet deep. Manholes are located at all bends, extending above high water and surrounded by embankments to prevent polluted river-water entering them. Gate valves divide the gallery into sections to facilitate repairs, but as yet no repairs have been necessary.

LAND FLOODING

Experience up to 1916 had indicated the ability of the gallery to produce about 1,000,000 gallons daily for each 1,100 lineal feet of river subject to infiltration, during the governing periods of drought. This is equivalent to about 220,000 gallons per day per acre of river bed.

It was recognized that too much raking of the river bars was of doubtful desirability (presumably because it would reduce the purifying effect of the infiltration) and about ten years ago, during a serious drought, the experiment was tried of pumping river water on to the land beyond the gallery, an embankment being raised so that this water, while on the surface, did not approach the gallery nearer than 100 feet, whence it seeped through the ground into the gallery. This proved very satisfactory, no deterioration in the quality of the water in the gallery being noticeable and the desired quantity being readily obtainable. The land that is flooded varies in character. None of it is pure sand, but most of it is sandy soil interspersed with some pockets of gumbo which inspection would indicate to be relatively impervious. In the fall of 1922 water was pumped on such land almost continuously at the rate of 5,000,000 gallons per day from September to December, inclusive, 35% of the total pumpage of the year having been obtained in this way. In ordinary years, however, the land flooding has been less extensive and practically none was necessary during 1923. In 1922 the area subjected to flooding reached a maximum of 13 acres and the average unit of filtration was approximately 385,000 gallons per acre per day. The flooded lands had not been cleaned since they were first used six or eight years before, except that the weeds have been kept cut.

"The engineers for the Water Department regard the flooding of lands rather as an emergency matter to tide over drought periods. It is believed, however, that the practice can be extended, thus making the gallery collecting system somewhat more capacious than it has been considered to be in the past."

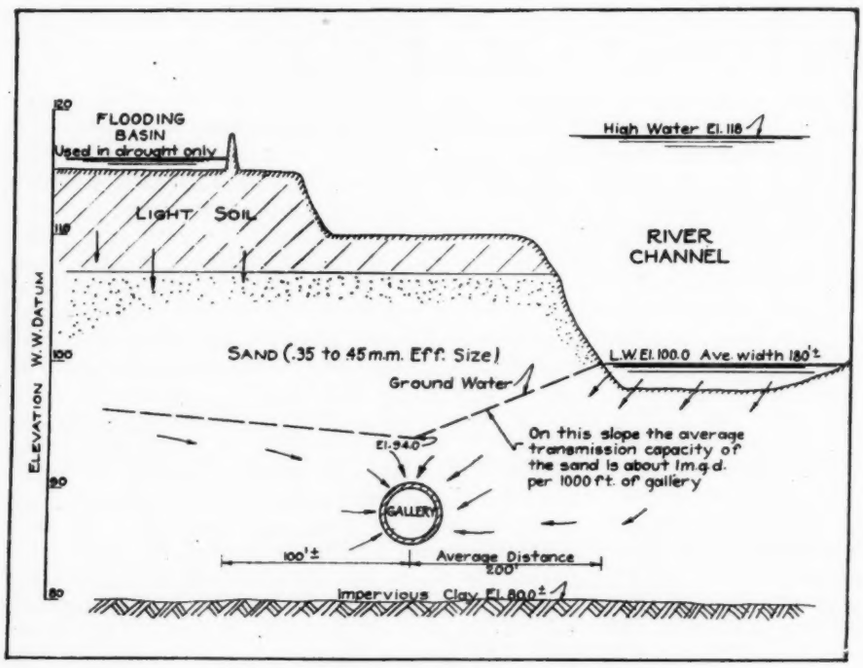
An important advantage of the gallery system is the storage furnished in both the gallery and the surrounding ground, the water level being generally several feet above the top of the galleries. If it be assumed that water to the amount of one-fifth of the volume of the surround sand for a strip 200 feet wide and 2 feet deep over the galleries can be drawn upon, this ground storage is equivalent to about 6,000,000 gallons. A much larger storage is actually available.

QUALITY OF THE WATER

The matter of the quality of the water is one which would naturally receive the early and earnest consideration of engineers. The water is moderately hard compared to western waters, varying from 220 to 340 parts per million and averaging about 280. The iron is generally less than 0.3 part per million, and while deposits are evident when flushing the mains, iron deposition never has been sufficient to cause serious complaint.

The river for many years past has been seriously polluted with sewage. It receives a small part of the sewage of Des Moines and all of that of Valley Junction, three miles upstream and with a population of nearly 4,000. The bacterial content usually runs from 10,000 to 20,000 per c.c., although it sometimes falls to 100 or 200 during the cold season.

As drawn from the gallery system, the water is clear and colorless at all times. It normally contains from 5 to 14 bacteria per c.c. on agar at 37 degrees, with coli occasionally present in 1 c.c. As a precautionary measure the water has been chlorinated since 1910. It is constantly under observation of a full-time chemist and assist-



TYPICAL SECTION OF FILTER GALLERY.

ant, the department having one of the best water testing laboratories in Iowa. The water after chlorination compares with the best filtered water. Its typhoid history is considered very satisfactory, only three deaths having occurred in the past three years and these having apparently no connection with the water supply.

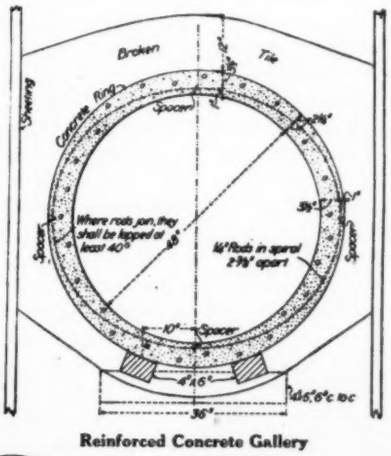
A complete record of bacterial tests of the municipal water for the year 1923 shows the following general characteristics: Bacteria per c.c. on gelatin varied from 9.36 to 173.25, averaging 32.82 in the untreated water; in the pump water the range was from 0.78 to 2.70, averaging 1.58; while in the tap water the range was from 0.78 to 4.63, averaging 1.74. On agar, the untreated water varied from 2.39 to 14.54, averaging 5.16; the pump water from 0.82 to 2.23, averaging 1.48; and the tap water from 0.85 to 2.19, averaging 1.44.

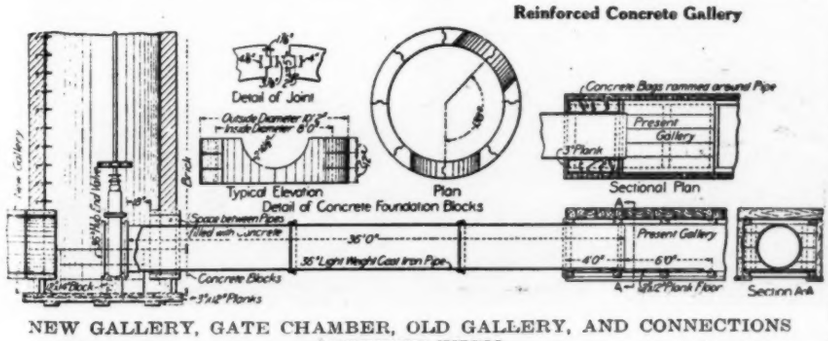
Tests for the presence of B coli were made on 295 days during the year, about twenty-five times each month, and the presumptive tests on the untreated water varied from nothing to 8.70%, averaging 1.69% in 1 c.c.; while in 10 c.c. the variation was from 12.50 to 48.15, averaging 25.76%.

Three hundred and seven tests were made for B coli of both pump water and tap water. Of pump water presumptive tests were positive in no case in 10 c.c. or 13 c.c., in one case in 17 c.c. and 25 c.c.; while in 50 c.c. presumptive tests were positive in 2.93%. Confirmatory tests in both 25 and 50 c.c. gave negative results in every case.

Of tap water no presumptive tests were positive in any amount smaller than 50 c.c., 3.26% being positive in such samples; while, as in pump water, no confirmatory tests gave positive results.

Records of the typhoid deaths for 1905 to 1923, inclusive, show rates per hundred thousand varying from 0.71 to 32.6. The latter was in 1910, and since that date the rate has not exceeded 19, which occurred in 1915. The next high rate occurred in 1918, when it was 11.7. Camp Dodge is believed to have affected the rate in 1918 and also that in 1919 when it was 7.2. In 1920 the rate was 2.38, that is, three deaths, while in 1921-22 and '23 there was one death only each year. Examination of the deaths by months would not seem to indicate any relation between them and the river pollution ordinarily caused by spring freshets, the highest rates being found in the last six months of the year.





NEW GALLERY, GATE CHAMBER, OLD GALLERY, AND CONNECTIONS BETWEEN THEM.

FINANCIAL

The value of this property was appraised in 1912 and given as $405,000, including about 200 acres of land which included and protected the gallery system. The cost of the water for the year 1923, assuming interest and depreciation at 6%, is figured to have been $5.66 per million gallons developed for interest and depreciation, and $4.15 for care and protection of the water supply (including laboratories and supervision) and for power; this giving a total of $9.81 per million gallons. A 5,000-foot extension to the gallery system which was constructed last summer cost approximately $30 per foot of gallery.

New Pumping Station for Chicago

Chicago is spending $7,500,000 on a new pumping station with a capacity of 300,000,000 gallons a day against a total head of 150 feet. Three million dollars is the cost of the station proper, which will be located at 49th Street and Western Avenue; the other $4,500,000 represents the cost of six miles of new tunnel, driven through solid rock, to connect the new station with the intake tunnel from the Edward F. Dunne crib. The total distance of the Western Avenue station from the intake point, two miles out in Lake Michigan, is about eleven miles.

This new tunnel was started in 1919 and has just been completed. Construction of the pumping station was begun September 1, last, and it is planned to have the station completed by September, 1927.

Four DeLaval driven centrifugal pumps will be installed, with a 600 h. p. Edge Moor four-pass boiler for each unit. The boilers will be fired by a battery of the latest type Taylor stokers similar to those now being installed at the Kearny plant of the New Jersey Public Service Electric Power Company, South Kearny, N. J., which are said by their makers, the American Engineering Company, of Philadelphia, to be the largest mechanical stokers ever built.

The plant is designed so that each unit can be operated separately when desired.

It is planned to operate the boilers at 100 to 200 per cent of rating with steam pressure of

325 pounds gauge and 225 degrees of superheat. All auxiliaries will be driven by direct current motors, the current being obtained from a generator driven by a non-condensing turbine. Steam will be bled from the main turbines to heat the boiler feed water to 210 degrees.

Low grade coal from the Indiana and Illinois fields is to be used. The coal will be dumped from the cars into a track hopper, crushed and elevated to reinforced concrete overhead storage bunkers. From these bunkers it will be distributed to the stoker hoppers by weigh lorries.

Ashes will be discharged from the stokers by a power ashdump and will then be handled by cars and a skip hoist to an overhead hopper, from which they will be removed by truck or railroad cars.

The stack is to be of radial brick, 9 feet in diameter at the top and rising 184 feet above the boiler room floor.

The design, construction and operation of the Chicago water supply system is under the direction of John Ericson, who has been city engineer for 26 years. Myron B. Reynolds is assistant city engineer, Loran D. Gayton is engineer of water works design, and James J. Versluis is engineer of water works construction.

Motorization by Chicago's Street Bureau*

Increasing use of motor equipment for street cleaning and refuse removal by the Bureau of Streets—Millions spent for equipment—Cost of operation and results obtained.

By William J. Galligan†

The motorization of the equipment used by the Bureau of Streets in street cleaning and refuse removal will be grasped more readily if the city's size and mileage are fully realized.

Chicago has a population of over 2,900,000; an area of 200 square miles (twenty miles in length, 10 miles in width). It has 2,300 miles of paved streets, 1,050 of unimproved; 450 miles of paved alleys, 1,350 of unimproved—a total of 5,150 miles of streets and alleys. It has 1,350 miles of street railways, with a daily passenger traffic of over 3,050,000.

In common with other cities, Chicago's street cleaning problem has greatly changed during the past 15 years. In 1911 the city's license bureau showed 73,226 horses and 13,944 motor vehicles, as against 26,321 horses and 296,441 motor vehicles at the present time. It is not, therefore, so much a problem of the removal of heavy dirt as of an opportunity for cleaning the streets at all.

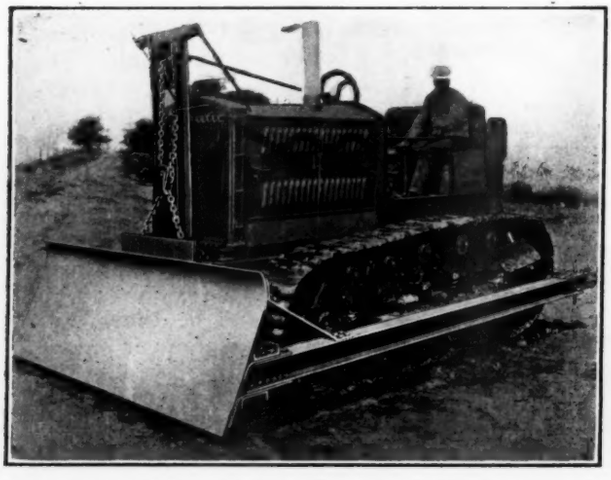
As automobile traffic increases, street cleaning in like ratio becomes more difficult and increasingly greater in cost. Seventy-five per cent of street dirt on the pavement finds its way to the gutters within a few hours. The demand for clean streets and the removal of snow constantly grows more insistent; but with all the thought and care given to traffic regulation, no consideration has been taken of the increased difficulty of street cleaning. If this branch of service is to continue to function, regulations must be made furnishing it the opportunity.

Owing to the immigration laws which restrict the class of laborers that are adapted for street-cleaning service, there has resulted a growing scarcity of acceptable men and a greatly increased rate of wages. Realizing that cities would be forced to seek other and more efficient methods, Chicago has been a pioneer in adopting mechanical equipment for street cleaning.

So far that installed in service includes flushers, sweepers, tractors and trailers, caterpillars, snow plows and loaders.

*Paper before American Society for Municipal Improvements.

†Assistant Superintendent of Streets of Chicago.



BULLDOZER USED FOR LEVELING DUMPS.

TRACTOR AND TRAILERS RECENTLY INSTALLED BY CHICAGO.

FLUSHERS

Flushers are used to supplement the work of the cleaning forces by washing the dust and fine dirt from the pavements. The downtown or "Loop" streets and those of the congested districts are flushed nightly. The main thoroughfares, business and traffic residential streets are flushed tri-weekly, others less frequently.

The city has twenty-eight 5-ton flushers of 1,500-gallons capacity, seven being trucks equipped with a single flushing unit which cost $9,000 each, and twenty-one trucks with double units, the total cost of which was $152,050.

Twenty-six of the flushers are operated in double shifts of 8 hours each between 12:30 P. M. and 6:30 A. M., while the remaining two are held in reserve to replace any that may be temporarily out of commission. Fifty-two crews, each consisting of a chauffeur and helper, are required to man the twenty-six flushers. The chauffeurs receive $7.50 per 8-hour shift and the helpers $6. The twenty-six flushers travel 1104 lineal miles each day and flush 11,925,296 square yards. The life of a flusher is estimated at 100,000 miles and the depreciation charge is made on the basis of miles traveled during the year in question.

The single units average 18 lineal miles per shift, consuming 2 quarts of oil at 12c. a quart and 12 gallons of gasoline at 15¼c. a gallon, making a cost of $2.07 for oil and gasoline. The twenty-one double units average 22 lineal miles per shift, consuming 2 quarts of oil and 15 gallons of gasoline, or a total cost of $2.53 for oil and gasoline. All flushers operate with 40 pounds pressure on the stream. For the year 1923, the cost of operation for a single unit, including oil, gasoline, grease, shop, labor, parts, tires, depreciation, chauffeurs and helpers, averaged $1.17 per lineal mile, while the double unit averaged 88c. per lineal mile. The average cost per thousand square yards was 8.4c.

It has been ascertained by careful observation and accurately kept records that the double unit not only gives better results in operation because of ability to control the stream regardless of the speed of the truck, but also is to be preferred on the point of economy since the double unit flushes on the average four more lineal miles of pavement to a shift than does the single unit with the use of only three more gallons of gasoline and of thirty tanks of water as against twenty-eight tanks by the single unit.

The single unit runs on second speed when flushing and the double unit on high speed. On car-line streets, 50 feet or less wide, one trip is made on each half of the street. On the first trip, which includes the center between the car-tracks, three nozzles are used on the single unit type and two on the double unit; while on the return trip two nozzles are used on both models. On residential streets, the full width of the pavement is flushed in one operation. With the single unit, good results are obtained only when the four nozzles are trained to the right of the direction traveled, while with double units, the nozzles are arranged to flush on either side of the street or both sides in one operation.

If present plans are carried out, twenty-two flushers will be added during the coming two years, making fifty in all, which will be sufficient for the city's needs.

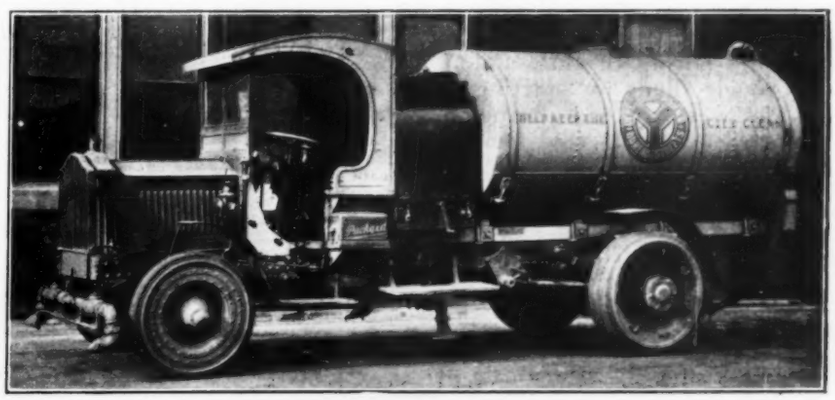
SWEEPERS

Chicago has eleven pickup motor sweepers, ten of which are used daily and one kept in reserve. They are used for the most part in the outlying wards where they are less liable to be handicapped by parked automobiles. These machines spray, clean the gutter, sweep the street and pick up the dirt in a single operation. They average five hopper-loads of dirt of 2¾ cubic yards each and consume ten gallons of gasoline and two quarts of oil in an 8-hour shift. The machine travels at the rate of 6 miles an hour. For heavy work the machine travels on second speed and the broom on fast speed, while for light sweeping the machine travels on high speed and the broom on slow.

TRACTORS AND TRAILERS

The motorization of Chicago's refuse collection equipment was begun in 1922. Previous to this time the inadequacy of the city's method of collection in dilapidated wagons, the excessive cost of refuse removal by hired trucks, the increasing distance of dumps and the advancing cost of operation had made it evident that some improved system was necessary. The City Council and the Street Bureau officials investigated the use of the tractor and trailer system in other cities and were convinced that it would give Chicago satisfactory service at less expense, and therefore made an appropriation for partial installation of the system.

As there had been no previous experience in the city with vehicles for this kind of service, a departure was made from the established policy of standardization and one 5-ton truck was pur-



DOUBLE-UNIT FLUSHER, PUT INTO SERVICE SEPTEMBER, 1920

chased from each of eight leading companies at a total cost of $42,357. In this way the city hoped to learn through experience which truck was best adapted to its needs. A similar practice was adopted in connection with the trailers, eighty-one of which were purchased from seven different manufacturers, forty-five of the knuckle type, reversible trailers, and the other thirty-six of the wagon type, non-reversible trailers. The total cost of these eighty-one trailers was $130,272.

Foremen of the dumps, superintendents of collection and equipment, engineers and officials of the Bureau have all made careful investigations of the operation and efficiency of these tractors and trailers as contrasted with the old method of team and motor truck haul, and all reports are favorable to the tractor and trailer system. Two makes of trailers were selected as giving most satisfaction under Chicago conditions, and 159 of these were purchased at a cost of $248,865. The city had been hiring trucks at the rate of $32.50 per day, but has made an arrangement with one company for renting twenty-five trucks, with an agreement that when the total amount of rental paid shall equal the price of the truck, the equipment will become the property of the city. This plan went into operation in August of this year, $400 per month being paid for each truck. Recently bids have been received for twenty-five additional trucks.

(To be continued)

San Francisco's $10,000,000 Water Bonds

San Francisco voters endorsed the proposed $10,000,000 water bond issue by a vote of 68,513 to 3.354. This bond issue is the first step in a definite financing and construction program designed to bring Hetch-Hetchy water to San Francisco in eight years. The proceeds of the bond issue are to be used to complete the 17-mile Foothill Range tunnel from the Moccasin Creek power plant to the San Joaquin Valley, to finance the sinking of shafts along the line of the 31-mile Coast Range tunnel to expedite the boring of this, and to provide funds for starting on the westerly end of this tunnel. It is expected that this issue will provide funds for this work for three years to come, at which time an additional bond issue of $23,000,000 will be submitted to the voters to provide funds for a 42-mile pipe line across the San Joaquin Valley and to complete the 31-mile Coast Range tunnel. It is estimated that the work to be provided for by this additional bond issue will take about 4½ years for completion.

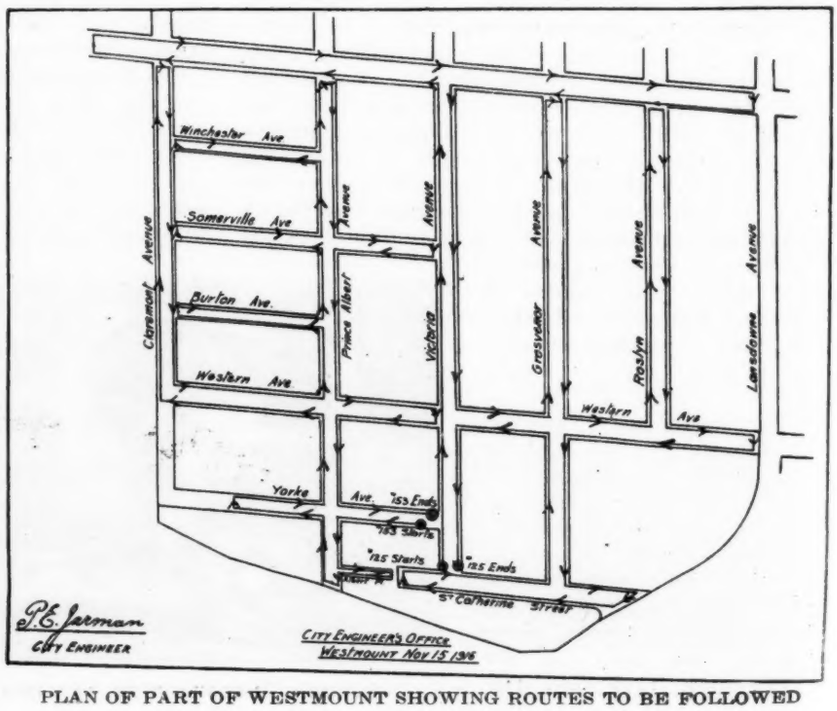
The city has already spent $45,000,000 on the Hetch-Hetchy project and the estimated $33,000,000 will bring the total cost up to $78,000,000.

Snow Removal in Westmount

The city engineer of Westmount, P. Q., P. E Jarman, describes in "The Municipal Review of Canada" the thoroughly worked out system employed by that city for the past nine years for cleaning snow from the sidewalks. His description, slightly condensed, is as follows:

The whole city was divided into ten sections, each small enough to be supervised by one foreman. To each section is allotted a sufficient number of drivers, horses, sidewalk plows, sleighs and other equipment to insure that, under normal conditions, the walks can be plowed out or sanded within two hours. Also enough laborers to remove the snow ridges thrown up by the plows when they cross intersecting walks and roadways, load sleighs and other work necessarily done by hand.

Each driver, horse and piece of equipment is given a number and allotted to sub-sections before winter begins; and each driver is given a plan of the streets in his sub-section showing the route to be followed in plowing the walks. This insures that no walk be missed or needlessly gone over twice, and drivers can easily be checked up on their work. Mr. Jarman states that the system is so elastic that drivers or equipment can be added or taken away if required.



PLAN OF PART OF WESTMOUNT SHOWING ROUTES TO BE FOLLOWED

Cleaning of roads was organized in a somewhat similar manner, care being taken to see that the more important streets are the first to receive attention, and that the route of the road plows extend through several sections so that the section foremen have just enough work removing ridges thrown up by the plows to keep their laborers busy.

The city has made a beginning at substituting machinery for horses, being equipped with blades, two 5-ton Holt tractors (especially useful on steep grades) and a 5-ton White truck. A 2-ton tractor for plowing walks was used successfully last winter. The city also has 22 snow plows for walks (presumably horse-drawn), a Stadig rotary snow plow, and two double and ten single snow scoops.

Sidewalks are sanded by the same system as the plowing, sand to be carried in carts or sleighs and spread by hand.

Last spring a gutter plow was tested out and proved so satisfactory that four were purchased. Each is drawn by either four horses or a tractor. By thus opening gutters quickly, there were few complaints of flooded sidewalks, although formerly the office had been flooded with them.

Refuse Incineration in New York

As we have stated previously, New York City is installing incinerators for disposing of its garbage, those already in operation including the largest in the country, it is believed. At the convention, on October 2, of the American Society for Municipal Improvements, Kenneth Allen, Sanitary Engineer of the Board of Estimate and Apportionment of New York, gave the following information concerning this plant:

"The 12th Avenue Incinerator, placed in commission last Spring, is of the Decarie type and of 300 tons nominal capacity (90 tons rubbish + 210 tons garbage or in all some 500 c.y.). As a matter of fact it is now handling some 370 tons of rubbish and garbage per day—about equal weights of each. Some 6 or 7% of this is metal.

"Material to be used during the day is dumped from the 8 c.y. trucks to a platform over the 6 50-ton units and charged by a traveling bucket of 2 c.y. capacity: 3 buckets of rubbish to one of garbage—about equal weights of each.

"As trucks stop delivering at 4 P. M. material to be incinerated during the night is dumped on the opposite side of the driveway, the garbage into containers holding 1½ tons or 4 c.y. These containers are then piled in rows until time to charge in the furnace, and, with the grab buckets holding the rubbish from the other pit, are handled by the traveling crane.

"Incineration takes 2½ to 3 hr. and by 6 A. M. all material is disposed of.

"Provision is made for the aid of oil as fuel, but this is never required. Combustion chamber temperatures are about 1500° F. and are sometimes said to reach 2200°. Incineration is complete and there is surplus unutilized power in steam at 100 lb. pressure. The chimney is 225 ft. high and 20 ft. in diameter at the base.

"The residue amounts to 18% of the original volume. If metals were excluded this would be reduced to some 6%.

"Aside from the man in charge of the station there are employed: 3 engineers, 36 firemen, 18 stokers charging, 18 stokers handling ashes, 6 men handling garbage, 9 cranemen, and 3 oilers.

"The entire plant is free from appreciable odor or nuisance of any kind and is equipped for efficient and clean operation. Shower baths are provided for the men. It is believed to be the largest plant of its kind in the United States and is the first of several which are now being planned to dispose of garbage of the Boroughs of Manhattan, The Bronx and Brooklyn, instead of dumping it at sea as at present."

Sewer Tunnel at Tulsa

Reporting on construction of sewers in Tulsa, Okla., city engineer Charles Schultz stated that building a part of a proposed storm sewer in tunnel rather than in open cut had saved a large sum of money to the taxpayers and property owners. Before deciding on tunnelling, however, a set of core borings along the center line of the tunnel was obtained by contract at $2.75 per lineal foot. These borings permitted the location of the tunnel to the best advantage so that all but 350 feet of the 5,100 feet was through solid rock. He believed that changing the sewer from the original project of open cut to rock tunnel saved the city about one-third of the cost of approximately $300,000.

Ventilating Public Passageways

The multiplication of automobiles has brought to popular attention the danger of poisoning by carbon monoxide, an invisible, odorless gas given off by automobile engines when operating. Prof. Yandell Henderson of Yale has stated that continuous breathing of air containing 2 parts of carbon monoxide is injurious, and 4 parts may be dangerous.

When discharged in the open air the gas is quickly dissipated and rendered harmless; but in an enclosed garage the air may soon become highly charged. This may also occur where many cars pass through or stand in a tunnel, and provision has been made for ventilating the Hudson river vehicular tunnel to prevent this. On May 10, a traffic tie-up in the Liberty tunnel, Pittsburgh, resulted in a maximum concentration of 25 parts of CO per 10,000 and much discomfort, with 12 hospital cases but fortunately no deaths. Concentration of the gas may occur in passageways, such as long railroad underpasses, or enclosed cab stands.

An illustration of the latter is the cab stand at the Grand Central Station, New York City, about 300 feet long, which is used by hundreds of automobiles an hour, which stand for short periods with their engines running. As much as 3 parts of CO per 10,000 has been found here. It was therefore decided to remedy this by artificial ventilation, which has been secured by the

installation of a large double-width turbo-conoidal fan built by the Buffalo Forge Co., having a capacity of 56,000 cu. ft. of air per minute, operated by a 75 h.p. motor direct connected. The outlet opening of the fan extends from about three feet above the floor to the ceiling of the passageway 9 ft. 4 in. above the floor. An air test made with the fan in operation showed 1½ parts per 10,000.

It is advisable that city officials keep in mind the danger of air poisoning in enclosed or partly enclosed public areas used by automobiles, and have tests made of the air in suspected places, making provision for ventilation where needed.

Ditching with Dynamite

Further development of the use of explosives for forming ditches for drainage and other purposes has been made recently by W. B. Alford, an expert of the du Pont Company. While the limits of such work were formerly set at 4 to 5 feet deep and 10 to 12 feet wide, Mr. Alford has blasted some 20 to 24 feet wide at the top and 12 to 18 feet at the bottom, and some as deep as 7 feet.

Widening and deepening existing ditches did not seem to be so practicable. But it was possible to load them on one side, lifting that bank and widening and deepening on one side only; but the cost was about the same as making a new ditch.

For blasting a wide ditch, two parallel rows of dynamite cartridges were set and detonated simultaneously; but the spacing must be just right or a ridge will be left in the bottom. These large ditches were blasted in various kinds of soil at an average cost of 18½ cents per cubic yard, the largest ditches costing somewhat more aged 14½ cents. Sandy soil gave lower costs than stiff soil and sandy marsh lands.

Borings for the Narrows Tunnel, New York

Some details are given, in the latest report of Chief Engineer of the Board of Estimate of New York City, of the borings made in connection with planning the Narrows tunnel, from which the following items of information are abstracted.

Four test borings made on Staten Island, aggregating 246.8 linear feet cost $821.70. Later a contract was let for further borings, both on land and under water, to the Pennsylvania Drilling Co., which was paid $26,354 for the same. Eleven land borings were made in Brooklyn, 907 linear feet of washing through sand, gravel and clay. Forty-five land borings were made in Staten Island aggregating 1,580 feet of washing and 1,167 feet of drilling for one-inch core, 125 dry samples being taken. Rock was encountered at depths below the surface varying from 4 to 88 feet, and the borings generally driven 10 to 20 feet into sound rock, but a number much further, one being carried 165 feet into serpentine rock. A cyclone drilling rig mounted on wheels and two tripod rigs with gasoline engines were used on the land borings. The drill (made by the Sanderson Cyclone Co.) was equipped with a 7 h.p. Cook gasoline engine.

Borings in the bay were made with a Keystone steam drilling rig mounted on a scow. Generally 1⅜-inch diamond drills were used. Twenty-seven borings aggregated 2,559 feet of washing and 123 feet of core drilling, 125 dry samples being taken. The materials penetrated were generally river mud covered at some places with a thin, hard crust, and blue clay or a mixture of this and sand. What rock was found was approximately 115 feet below mean sea level. The sub-aqueous work was remarkably free from difficulties and accidents and only one boring had to be completely abandoned. Payment was on the following basis:

2,487.4 lin. ft.	casing for 1" cores	@ $2.25	$5,596.66
1,167.4 lin. ft.	drilling 1" cores	@ 3.00	3,502.20
2.558.5 lin. ft.	casing 1⅜" cores	@ 5.75	14,711.38
123.2 lin. ft.	drilling 1⅜" cores	@ 10.00	1,232.00
328	dry samples taken	4.00	1,312.00
Total cost			$26,354.24

Replacing Old Paving Brick

A brick pavement that had been used for more than thirty years, although poorly constructed on a broken stone base, was resurfaced by the city of Butler, Pa., last year, and a large number of the old bricks were used again. The cleaning of the brick and removal of the sand cushion (partly loam and 2 to 3½ inches thick) are described by Fred W. Harper, city engineer of Butler, as follows:

"The labor conditions in the spring were quite serious, therefore the question of cleaning the old brick had to be considered. To overcome this I contracted with school boys during the summer vacation to do this cleaning at the rate of five dollars per thousand for removing, cleaning and piling the brick along the curb. I might state that this worked out very well, giving employment to the boys, who made from two to three dollars per day, and saving the city from three to four dollars per thousand.

"The old sand cushion was removed by means of a road machine and tractor, leaving the crushed stone base. This was replaced and brought up to the proper height with crushed slag and the use of a template. It was then thoroughly rolled with an eight-ton roller, which settled it about one-half to one inch, on which was placed five-eighths of dust limestone or slag screenings to form the bed for the brick. The brick were then turned, laid, rolled and pitched in the usual way, forming as smooth a surface as though we had used new brick.

"On completion the measurements showed that we had removed 4,713 square yards, of which 4,083 yards were relaid with old brick which had been in use for thirty-two years, at a cost of

$1.25 per square yard; and 630 square yards of new repressed brick at $2.75 per square yard; both prices including filler."

Creosoted Wood Blocks in 1923

In a report on the quantity of wood treated and of preservatives used in the United States in 1923, published by the Forest Service of the United States Department of Agriculture and prepared by R. J. Helphenstine, Jr., of the Forest Service, it is stated that in 1923 a total of 1,878,974 square yards of wood blocks was subjected to preservative treatment, this being an increase of about 375,000 square yards over the quantity reported the year before. Of the quantity treated, about 30%, or 572,000 square yards, was intended for outside paving and the remaining 70% for inside flooring. All of the wood blocks treated were Southern Yellow Pine with the exception of about 24,000 square yards of Douglas Fir.

Paving oil, creosote, carbolineum oils and creosote in mixture with crude oil were the preservatives used in the treatment of this class of material. Where the blocks were intended for inside flooring, the amount of preservative ranged from 4 to 12 pounds per cubic foot, while for outside paving it was from 12 to 20 pounds. The full cell, empty cell and open tank processes were employed.

Street Lighting in Norwood

Norwood, Ohio, a municipality adjoining Cincinnati, has recently installed a street-lighting system consisting of 120 ornamental cast-iron posts of the design adopted as a standard for ornamental street-lighting systems for Greater Cincinnati. These posts are spaced 80 feet apart and are of such height as to bring the light center 12 feet 8 inches above the sidewalk. The lamps used are 6,000 lumen, 20 ampere, Mazda C. To insure safety they are operated from the secondary side of a transformer located in the base of a post, this arrangement permitting a low voltage circuit independent of the underground system used in the post itself.

The glassware was developed especially for the Greater Cincinnati system by local engineers in conjunction with engineers of the Westinghouse Electric & Manufacturing Company. It consists of two parts, a globe and a canopy, both of Monax diffusing glass, which are assembled in one unit by an ornamental metal band, the canopy being arranged with a watershed so that rain will drip from the canopy instead of running down the globe as in other types. The method of assembling the globe and canopy with an ornamental band eliminates shadows which are cast on the globe when internal metallic attachments are used. The globes are attached to the casing by means of a new globe holder known as the "Jiffy," which facilitates the removal of the globe for cleaning and relamping and reduces danger of breakage when handling.

NORWOOD LIGHTING UNITS BY DAY.

VIEW OF SAME STREET BY NIGHT.

Improving Pavement Subgrade

Use of sand or other porous material under base eliminates or largely reduces objectionable features of clay.

In a paper before the recent convention of the American Society for Municipal Improvements, Clarence D. Pollock discussed the "Improving of Pavement Subgrades by the use of Porous Material," a subject concerning which he had reported the year previous. "When the subsoil consists of sand or other good granular and porous material," said he, "it has been found that a foundation 6 inches in depth of the standard 1:3:6 mixture of Portland cement concrete is ample to place under pavements to carry modern traffic; but the question is, what is to be done when the soil consists of clay or other material which may become plastic and will not afford sufficient support for the foundation during at least part of the year?"

He believes that, if the soil is one that absorbs

much water, no practicable depth of concrete will be sufficient to resist the heaving of the soil and consequent breaking of the base. "It has been found that, with clay against the under side of the concrete, when there are even very small differences in temperature between the clay and the concrete, there is a condensation of moisture on the under side of the concrete which freezes in cold weather and thus adds to the volume increase and consequent heaving of the pavement. With a porous layer between the foundation and the clay subsoil there is no condensation on the bottom of the concrete and thus this trouble is avoided."

Mr. Pollock stated that attempts to control the moisture content of the subgrade clay in the Bates road tests proved a failure. No system of drains seems able to reduce the moisture in clays below their normal content. Consequently the prevention of the heaving and other objectionable features experienced with clay subsoils cannot be prevented by subdrains and the use of a layer of porous material seems to offer the best solution.

"Between the sands and the clays there are many soils which are mixtures. Which of these will properly support a pavement and which will require a porous layer under the pavement foundation? The Bureau of Public Roads is now investigating this side of the problem. Because of the many kinds of clays in the soils and their different effects, it is probable that no very definite rules may result, but some general conclusions may be drawn, such as that a soil high in clay and high in water absorption will usually have a high volume change, and consequently require the placing of a granular layer at the subgrade. The judgment of the engineer, from his experience, must play an important part in deciding where to draw the line, however. Naturally there are many cases of streets and roads where the clay will be found only here and there in pockets, and it will be necessary to place the porous layer at these points only. Other cases will occur where it may be more economical and serve the purpose as well to add a small amount of sand to the soil and plow or otherwise work it into the subgrade in order to make it sufficiently porous.

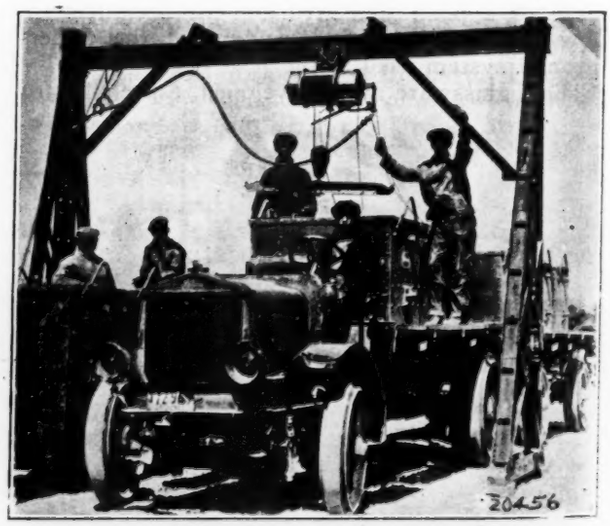
"Studies are now being made to determine the proper thickness of the granular layer when it is required. The writer has obtained good results by the use of 5 inches and even with 4 inches, and understands that others report excellent results with some clays by using a thickness of 3 inches of granular material. In tests with some clays and a careful placing of the sand layer, a 2-inch depth has proven successful, but it would seem better to use a greater thickness than two inches because of the difficulty of obtaining sufficient uniformity of depth in actual construction."

The granular layer also serves to distribute the wheel load over a larger area of subsoil, and this feature may permit a slight reduction in the thickness of the concrete base. Where there are to be cuts in the pavement for opening trenches, it may not be desirable to reduce the thickness of the base below 6 inches, but where few openings may be looked for, it is probable that a considerable saving may be secured. "The writer has laid a large amount of granite block pavement on a 5-inch cement concrete foundation on sandy and gravel subsoils without foundation failures, as well as many miles of asphalt similarly without foundation troubles. Likewise, he has had excellent results from a rolled broken stone base over a similar subsoil when the location was such that it was not subjected to trench openings, and was paved with granite blocks subjected to heavy truck traffic."

The author states that, while we have for years been endeavoring to standardize foundations and wearing surfaces, it is time that we paid some attention to standardization of the subsoil, by bringing those of poor supporting value up to proper standards.

Air Hoist on Road Work

The Hill & Hill Construction Company, in building a concrete highway near East Orwell, Ohio, found that the roads leading to the work were of such a nature that heavy motor trucks could not pass and that therefore it seemed the best solution to utilize a railway that ran near the new roadway. Unless some special plan were worked out, it would be necessary to load the materials first on motor trucks at the storage plant, from these onto railroad cars, and from the cars to trucks again at the scene of operation. The plan adopted, however, was to mix the materials at a central plant and transport them in steel hoppers, which were placed on the railroad cars and thus transported to the site of the work. Here the mixed material was transferred to motor trucks by means of an air motor hoist receiving its air from a portable compressor, the hoist being suspended from an I-beam by a four-wheel trolley, the I-beam in turn being supported at each end



AIR-DRIVEN HOIST UNLOADING HOPPERS FROM A MOTOR TRUCK AND TRAILER.

by two legs of structural steel, the whole forming a "horse" large enough to straddle both motor truck and freight car. The compressor was a 4½ x 4-in. Ingersoll-Rand, and the air motor hoist, manufactured by the same company, had a capacity of 4,000 pounds, and not only lifted the load but, operating as a trolley, moved itself to the desired place on the beam.

Reinforcement in Concrete Roads

An investigation of the economic value of reinforcement in concrete roads is being made by the Highways Research Board of the National Research Council with the co-operation of various state highway commissions.

A recent notice issued by the Board states that, except in cases of actual failure, inspections will concern principally pavements having had at least five years of service, a great number of which are located in New Jersey, Ohio, New York, Pennsylvania, Delaware, Michigan, Wisconsin, Iowa, Illinois and California.

An effort will be made to determine the influence of steel reinforcement on the resistance of the slab to traffic, subgrade and climatic conditions; the conditions under which steel reinforcement is especially beneficial to concrete slabs; the effect of slab design on the efficiency of reinforcement; and the relative cost of plain and of reinforced concrete roads, considering both initial investment and annual maintenance and renewal charges.

A study will be made of different slab, traffic and climatic conditions, the general characteristics and properties of the subgrade, and the drainage conditions. Original data will be studied to learn the materials and proportions entering into the concrete, method of construction and cross section while careful note will be made of joints, cracks, replaced areas and general surface conditions; grade, alignment, location and maintenance. Field inspections will probably have been begun in the northern states by the time this is published and will be transferred to the southern states with the advent of cold weather. It is expected that a progress report will be ready for the annual meeting of the Advisory Board on Highway Research on December 4 of this year.

Paver Mixer for Sewer Construction

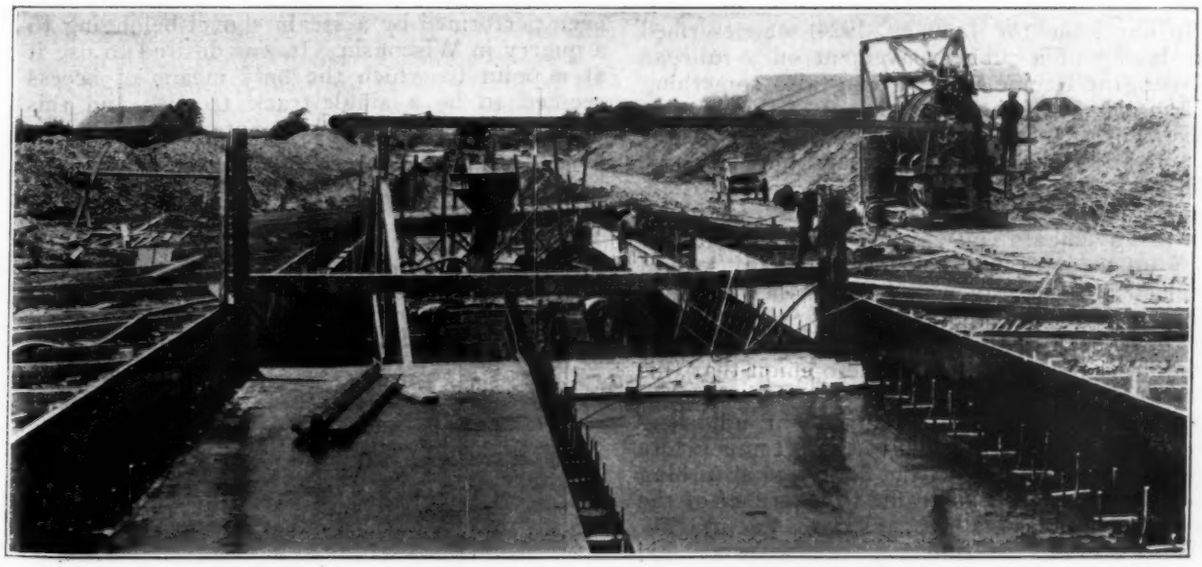
Two contractors on sewer work near Milwaukee have this summer used with apparent success paving mixers for constructing large concrete sewers. The ability of these portable mixers to turn out large quantities of concrete, place it directly where wanted by boom and bucket distribution, and follow along readily as the work progressed, was the reason for adopting this plan.

The work consisted of a section 3200 feet long of double barrel sewer, each opening 6 ft. high by 8 ft. 6 in. wide; continued by a round sewer 6,000 ft. long with diameter varying from 8 ft. to 6½ ft.

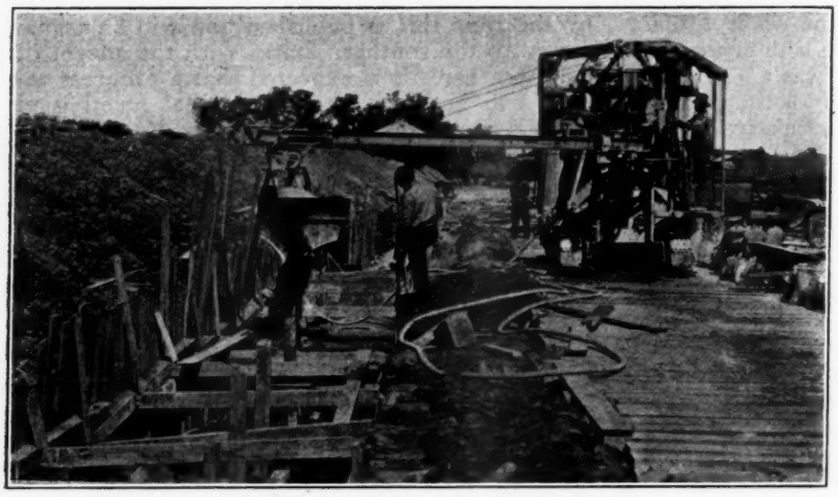
The double sewer was built by the Clayton Construction Co., of Milwaukee, which began the work on June 12 and completed it about Sept. 6, completing an average of 76 lineal feet per working day, or a little over 200 cu. yds. The outside walls were 12 in. thick, the central wall 9 in., the bottom 16 in. and the top 18 in., all reinforced.

A central proportioning plant was located at the middle of the job, where were located Butler bins for sand, stone and cement. The sand and stone bins were filled by means of a B. G. belt conveyor with aggregates brought by supply trucks; and the proper proportions for a batch were drawn from the bins into batch trucks, which carried them to the mixer on the job.

Here was used a Koehring 21E paver which had been furnished with a special boom 45 ft. long, so as to reach the further side of the 25-ft. trench and



USING PAVER WITH 45-FOOT BOOM FOR CONSTRUCTING SEWER.



CONCRETING ON THE ZIMMERMAN JOB.

permit the mixer to stand well back from the edge. The outer end of the boom was supported by a light, portable frame support that was moved from time to time by two men as the work and the mixer progressed.

The second section is being built by the George F. Zimmerman Construction Co. of Milwaukee, which began work on August 1 and expects to complete it this year. This firm is using much the same method, but a smaller mixer—a Koehring 13E paver, with a standard 20-ft. boom, which has averaged well over 600 bags of cement, in a 1-2-4 mix, per day. This concrete is mixed unusually dry because of the large amount of water in the trench, which is through swampy ground. Four shovelfuls of hydrated lime were mixed with each batch to give the concrete additional smoothness.

Rubber Pavements on Bridges

In our issue for January, 1924, we described the laying of a rubber pavement on a railroad crossing at Racine, Wis., giving also something of the history of the development of this kind of pavement. At the October convention of the American Society for Municipal Improvements, Edgar S. Dorr, consulting engineer, of Boston, read a paper entitled "Development of Rubber Block Pavements" in which he brought the history up to date and showed samples of several kinds of rubber pavement. Also the members were invited to examine a pavement in use on the draw span of the Northern Avenue bridge in Boston. Several expressed the opinion that this class of pavement was especially suitable for paving bridges, being light in weight, adjusting itself without deterioration to slight temperature and other movements of the floor, and absorbing much of the jarring of traffic to the relief of the bridge members.

Two sections of rubber pavement were laid on the Boston bridge, each 18 feet square, one on May 7 and the other on on May 14. The material is a combination of about one-third new rubber and two-thirds old automobile tires, vulcanized at about 330° and pressed into blocks under 2,500 pounds pressure. The blocks are 6 by 12 inches, one inch thick, alternate courses having a corrugated surface. Each block has two semi-circular flaps on one side and one on the end, which extend under and fit into corresponding depressions in the bottom of the adjacent blocks. The blocks are cemented to each other and to the wooden bridge floor and in addition are fastened by spikes driven through the flaps. Four men laid the floor at the rate of 60 square feet an hour.

This bridge carries heavy industrial and freight yard traffic, said to reach 1,000 vehicles per hour in each direction. The pavement shows no signs of distress under this traffic and is expected to last twenty years or more. Plank flooring on this bridge had to be renewed frequently.

Similar blocks—"Wright rubber tiles"—have been laid on the Eads bridge at St. Louis, and on October 1 Chicago started laying them on the boulevard link bridge, where nearly 20,000 square feet of sidewalk and roadway will be covered. This pavement costs three or four times as much as wood block, but it is claimed that the life is much longer, there being practically no wear, and that the silence and other characteristics already mentioned give it special value for certain locations.

Steam Shovel Crosses Trestle

A remarkable and nervy stunt is said to have been performed by a steam shovel belonging to a quarry in Wisconsin. It was desired to use it at a point to which the only means of access seemed to be a single-track trestle; and this steam shovel, which was mounted on caterpillar

RUBBER PAVEMENT ON BRIDGE, BOSTON.

traction, crossed the trestle on the rails, although the treads projected over the track on each side. The driver of this shovel certainly had great confidence in his ability to steer the shovel and in the reliability of its steering mechanism.

Federal Experiments on Concrete Pavements

Conclusions from tests made by the Bureau of Public Roads on various types of concrete pavement in an experimental road on the Columbia Pike. Effect of subgrade and reinforcement.

Observations of the Columbia Pike, an experimental road constructed by the United States Bureau of Public Roads near Arlington, Va., after two and a half years' service under traffic have made possible a number of conclusions with regard to the relation between the cracking of concrete roads and the character of the subgrade and steel reinforcing. The observations also reveal a number of interesting facts with reference to the water-holding properties of the soils composing the subgrades and the relation between these properties and resulting changes in volume. A description of the test and statement of the conclusions are given by J. T. Pauls, associate highway engineer of the Bureau, in a statement recently made public by it, from which the following is abstracted.

It is found that subgrade materials with a large percentage of clay not only attain a high moisture content during the wet season but retain a high content during the dry season. Materials of this character subjected to the laboratory test for moisture equivalent will be found to have a high moisture equivalent value. Subgrades having a large percentage of sand do not attain high moisture content. It is also found that subgrade materials composed largely of very fine sand have high capillarity and that under this condition free water will very often be found between the pavement and the subgrade.

The subgrade of this road varied greatly at different sections in its moisture content, which varied from a maximum of 43 per cent to a minimum of 8.2 per cent in wet weather, and from 28 per cent to 5.5 per cent in dry.

It was found that in a cut, subgrades will absorb and retain more moisture than over a fill.

Subgrades composed largely of clay swell and contract as moisture is added or taken away. The effect of this in the case of swelling is to lift the pavement at the edges and on contraction to take away the support at the edges. The result is that the slab, acting in one case as a simple beam and in the other as a cantilever, is broken at the center by traffic. The conclusion is drawn from the observations that subgrades that show as much as 10 per cent volume change, by laboratory test on an entire sample including coarse material, should be covered with a layer of coarse granular material, and a pavement laid on a subgrade of this character should have a longitudinal joint at the center.

Those sections in which longitudinal joints were constructed (about two-thirds of all the sections) were in all cases free of longitudinal cracks. Where the subgrade was of material that changed in volume considerably, however, the longitudinal joints opened up due to the movement of the two halves of the pavement about this joint as a hinge.

Longitudinal cracks in a pavement indicate an unstable subgrade either as to supporting value or movement caused by moisture changes. Adding a granular material to such a subgrade increases its supporting value and modifies the effect of any volume change. Pavements on this type of subgrade should be designed with a center joint.

In constructing one section over clayey material, cement in the proportion of 1 to 28 was mixed with the soil to a depth of 6 inches, and this section had no longitudinal cracks, although those on each side of it cracked badly. It is very likely, however, that a layer of cinders or other granular material, such as coarse sand, would have provided approximately the same results.

The observations made indicate that plain concrete slabs will crack transversely because of temperature and moisture changes at intervals of from 40 to 60 feet. Smoothness of subgrade surfaces increases the distances between cracks, but the thickness of the concrete does not affect the spacing of the contraction cracks. Additional thickness of edges does not reduce the number of contraction joints, but does keep down the number of additional cracks caused by heavy traffic.

Judging by the experience with the experimental sections, pavements reinforced longitudinally will develop transverse contraction cracks, the number, spacing, and size of which will be controlled by a number of factors. If the steel reinforcing is not continuous but is separated by joints, it is to be expected that no cracks will form less than 30 feet from any joint; and by a suitable relation of the percentage of steel to the length over which the steel is made continuous, the distance may be increased to 60 feet. The position of the cracks will be influenced by the strength of the concrete and the roughness of the subgrade as well as by the percentage and continuous length of the steel. If the spacing of the joints is less than twice the distance in which a crack would form, contraction cracking may be entirely prevented. If the distance between joints is extended, a crack may be anticipated at a distance of 30 to 60 feet from each joint and the area between these cracks may be expected to crack at relatively short intervals. With a high percentage of continuous steel, relatively fine, closely spaced cracks may be looked for; with a low percentage, breaks in the steel may be expected to permit wider cracks to form at considerable intervals. Mesh reinforcing in amounts as used in these tests is likely to break at intervals and permit open cracks to form.

Attention should be called to the possible danger of the use of too high a percentage of longitudinal steel, for under such conditions numerous fine transverse cracks will develop and there is the possibility that the narrow transverse beams thus formed will crack under traffic.

From the results obtained on sections reinforced longitudinally it would appear that the practice of

omitting contraction joints in pavements of this type is questionable. It would appear that where longitudinal steel is used the design should provide for contraction joints from 50 to 100 feet apart with the steel designed to prevent intermediate contraction cracks from forming. Another method that would probably be more satisfactory to the contractor, but which might be subject to other objections, would be to make the concrete continuous and to break the steel one-half inch or 1 inch at intervals where it is desired that contraction cracks shall form.

These conclusions will, no doubt, be modified in certain respects and in others made more conclusive as time permits the action of the various factors to become more effective. The results obtained thus far show conclusively the great importance of subgrade investigations in connection with the design of a pavement. Since the character of the subgrade may vary widely in a comparatively short section of road, it seems logical that the design should be modified accordingly so as best to meet the particular subgrade conditions existing, or that the subgrade should be so corrected as to make it suitable for a uniform design of pavement.

Film Removal in Sprinkling Filters *

By Willem Rudolfs†

Tentative conclusions from botanical, zoological and bacteriological studies of the Plainfield filters—Effect of worms in loosening film.

In an effort to learn more about the growth around the crushed stones at different levels of the filter beds at the Plainfield plant, ordinary bricks were placed in sampling holes of a pit constructed in the middle of one of the four sections of the filter. The pit is 36 x 32 inches in cross section and 70 inches deep. In one face of the pit, holes have been cut 7 inches wide and 8 inches high, one below the other, and extending from these holes 2 feet into the stone body of the filter are galvanized square meshed wire forms. The holes are closed by hinged wooden boards. The bottoms of these holes are approximately 1, 3 and 5 feet, respectively, from the surface of the sprinkling filter. The holes are referred to as 1, 2 and 3 in the figures in order from top to bottom. In these holes sampling bricks were placed. At regular intervals the bricks were scraped free from material and the wet film so removed was weighed separately and the material used for identification and enumeration in the botanical, zoological and bacteriological studies. It was thought that the weight of the wet film could furnish information, (a) regarding the loosening of the film around the stones, (b) as to whether or not this loosening was spontaneous throughout the bed, (c) concerning a possible transgression or overlapping of the film removal, (d) in regard to the relation between animal and plant growth in the bed and thickness (weight) of film.

If the periodic loosening of the film (slough) were spontaneous, the influence of moving worms in the film would be nil or perhaps detrimental, while an overlapping of film removal in the different parts of the bed, together with changes in free moving animal population, especially Nematode worms, would possibly furnish information as to the mechanical work performed by these worms. These worms occur frequently in large numbers.

The accumulation of wet film and suspended solids in influent and effluent samples was determined for a period of about 250 days, including the period of unloading, during 1922. A comparison of the suspended solids in the influent and effluent samples shows an increase in the solids found in grams per day. The solids in the effluent in p.p.m. are plotted in fig. 1 together with the total weight of film and that found at the three different levels of the bed. The solids in the effluent vary with the total film removal, but a glance at the lower part of the figure seems

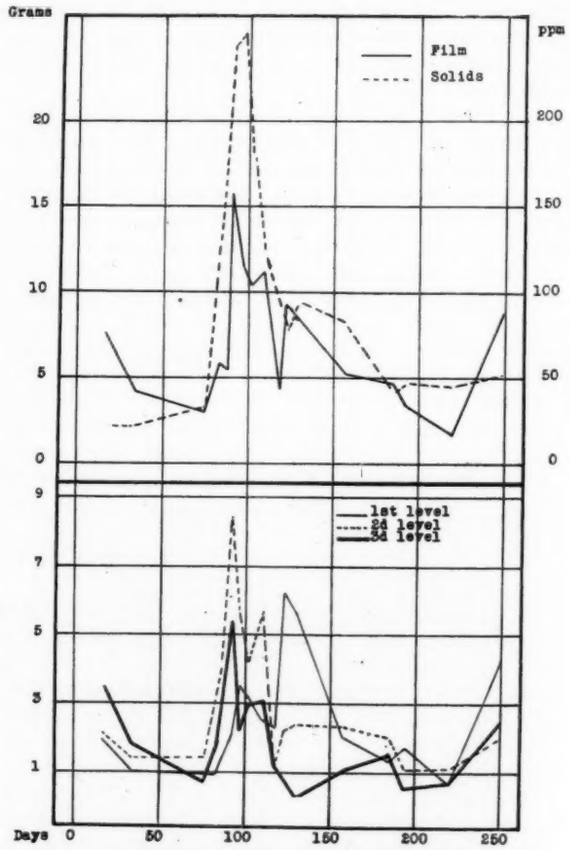


FIG. 1—RELATION BETWEEN SUSPENDED SOLIDS IN THE EFFLUENT AND THE AMOUNT OF FILM FOUND AT DIFFERENT LEVELS OF THE FILTER BEDS.

*Paper No. 199 of the Journal series of the N. J. Agricultural Experiment Station and N. J. State Dept. of Health, Substation Sewage Investigations.

†Chief of sewage investigations, Sewage Investigations Laboratory, State of New Jersey.

to indicate that the heavy unloading at the different levels is not spontaneous and regular at all depths.

Fig. 2 shows the amount of film collected on the bricks at three levels during the period of May 28, 1923, to April 8, 1924. It is interesting to note that an increase in the weight of the film occurrred several weeks before the unloading became apparent in the effluent. Rapid accumulation of the film on the bricks was noticed on Sept. 23, while the slough was observed in the effluent on Oct. 22, or about a month later. The same facts were noted during the spring slough which was much heavier. From Fig. 2 it is clear that the film moved from top to bottom and that the largest amounts were discharged from the level nearest the bottom considerably later than from the other levels.

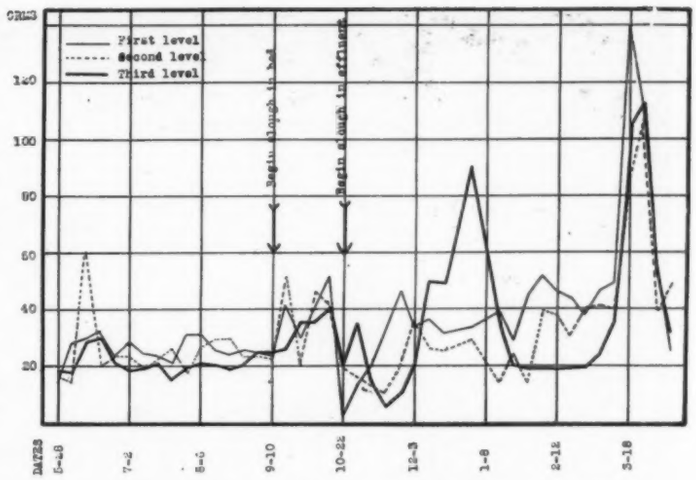


FIG. 2—AMOUNTS OF WET FILM, IN GRAMS PER DAY, FROM THE 1 FT., 3 FT. AND 5 FT. LEVELS OF THE FILTER BEDS; 1923-24.

Our zoologist has found at certain periods of the year large increases in annelid and nematode worms. It is possible that the animals, by their movements through the film, hasten the loosening of the accumulated debris, migrate with this film material loosened from the higher levels, and continue their work in the lower layers of the bed until they are washed out. It is conceivable that the propagation of these particular animals is beneficial to the efficiency of the beds, especially since better nitrification has been observed after the slough.

Total film accumulation and changes in total animal and plant growth are compared in figure 3. Fungi are not counted but estimated. The total animals are given in hundreds of thousands per cubic centimeter. When film removal is started within the bed several species of protozoa increase rapidly in numbers. There seems to be a succession of groups. After some time when debris accumulates and fungi becomes more abundant the large numbers of free swimming protozoa disappear. Total growth fluctuates considerably during the year, but a steady increase of film takes place until its accumulation results in a new slough.

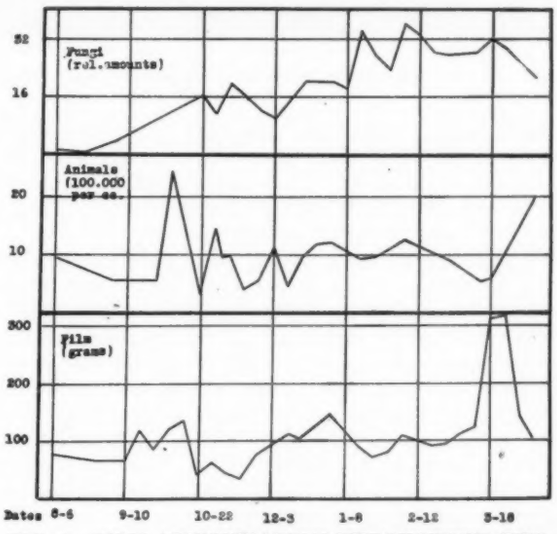


FIG. 3—FILM ACCUMULATION THROUGHOUT THE BED AND CHANGES IN ANIMAL AND PLANT GROWTH.

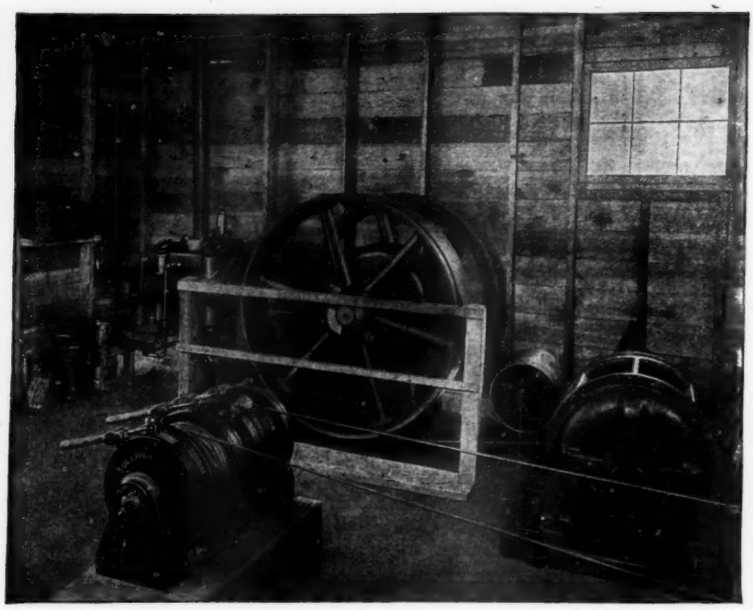
Sewer Tunnel in Cleveland

During the past year Joseph Winterbottom of Cleveland, Ohio, has constructed a sewer in tunnel in Lakewood, a suburb of Cleveland, which is part of the main intercepting sanitary sewer which will eventually parallel the lake from the Cleveland city limits to the boundary of Lakewood at Rocky river, intercepting the dry-weather flow from all sewers now discharged into the lake and carrying it to a disposal plant to be located on Rocky river. This particular contract called for about one mile of sewer with an egg-shaped cross section equivalent to a 48-inch circle. The tunnel is in shale rock throughout, the only earth encountered being in the shafts, of which there were two. The tunnel was operated from these two shafts and a heading at the river bank.

In sinking one of the shafts, which is about 90 feet deep, quicksand was encountered and a steel caisson was used for sinking it, an orange-peel bucket being used to remove the dirt from inside the caisson. The bucket had a capacity of ¼ cubic yard and was operated by a Sullivan double-drum "Turbinair" compressed air hoist which was placed in a temporary power house. The bucket requiring one cable for lowering and the other for closing it when full and raising it to the surface, the boom was attached to the top of the mast by a cable which was not adjustable and left the boom free to swing but could not be raised or lowered, thus permitting the use of both drums for the bucket.

In ordinary shaft work where pick and shovel were used and in solid rock, the excavated material was loaded into ordinary buckets and raised by the same hoist, but in this case one cable was used to operate the bucket and the other to raise and lower the boom of the derrick in the ordinary manner. A stiff-leg derrick was used, set up in the middle of the street.

The air was provided by a Sullivan Class WG-6



BELT-DRIVEN COMPRESSOR AND HOIST.

single stage compressor operated from an electric motor with short belt connection, making a very compact installation. This compressor operated the hoist and also three rotator hammer drills used in drilling rock, and a sheet pile hammer.

The shale through which the tunnel was driven was found to contain natural gas and it was necessry to secure continuous abundant ventilation to keep the tunnel clear of gas, for which purpose centrifugal fans were installed at the shaft for forcing in fresh air, while to provide exits for the foul air the contractor drilled several holes from the surface to the tunnel by means of a well drill.

One of these ventilation holes developed a considerable flow of gas about 10 feet above the tunnel but no effort was made to utilize it.

On the completion of the tunnel it was lined with Amco vitrified blocks.

The city engineer was E. A. Fisher and R. L. Squier was resident engineer.

Vertical Sewer in Ontario

The city of Niagara Falls, Ontario, has recently constructed, in connection with an outfall sewer, a vertical section about 200 feet long, thus forming a shaft. The reason for this was that the discharge is to be into the Niagara river below the falls, and in order to avoid nuisance and disfiguring the cliffs which forms a part of the scenic effect of the Gorge, the sewage was discharged at water-level, several hundred feet below the level of the town.

The construction of the shaft or vertical sewer involved several novel features. It was excavated down from above to a depth of about 30 feet, and at the same time an inclined shaft was run in from the foot of the cliff to a point directly beneath. A 6-inch hole was then drilled on approximately the central line of the shaft, which served to ventilate the heading of the shaft which was carried up from the bottom. To facilitate working on the roof, a timber box was carried up vertically inside the shaft, but leaving sufficient space between one end of the box and the side of the shaft to permit workmen to climb up to the top of the box, which was kept up to within a few feet of the horizontal working face. The spoil from the excavation was allowed to accumulate in this box and kept practically level with the top of the box by drawing off sufficient spoil from the bottom of this box or vertical chute. The men who worked in the shaft were all equipped with steel army helmets to protect their heads from small stones which might fall.

HAULING SPOIL FROM SHAFT WITH BUCKET.

The shaft was made with a horizontal section of 4 feet by 8 feet and was lined with concrete, steel forms in 5-foot sections being used.

Drinking Water Along Highways

At least four of the states are paying considerable attention to the matter of the safety of wells, springs and other sources of drinking water used by automobilists and others traveling on highways. One of these is Pennsylvania. The Department of Health of that State has its sanitary engineers engaged in this work and at the latest report they had covered 1,500 miles of road and made 725 examinations. Of the supplies examined, 275 were found fully satisfactory, 130 were unsatisfactory, 75 were capable of physical improvement. 175 were public supplies.

The sanitary engineer, in traveling the road assigned to him, takes note of all wells or springs that seem to be much used and makes a physical examination. If the physical examination indicates the supply to be satisfactory, a temporary marker is placed on the well or spring. The engineer is followed by a traveling laboratory which makes chemical and bacteriological analyses of supplies on which it finds the engineer's temporary markers. Where these chemical and bacteriological analyses show satisfactory quality of the water, this is indicated by a placard; when the supply is found to be unsafe, it is closed or a warning sign is attached to it. Where the unsatisfactory conditions can be remedied, instructions to the owners indicating how this can be done are furnished by the Health Department officials and these supplies are examined again later.

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A. PRESCOTT FOLWELL, Editor

CONTENTS

Artificial Ground Water

How Des Moines increased its ground water supply by pumping sewage-polluted river water onto the surface of the ground a short distance from its infiltration galleries is described in this issue. The supply so obtainable would seem to be limited only by the volume of river flow and area of land available for flooding.

This method, while not generally used in this country, has become more or less common in Europe during the past twenty-five years. The plant at Frankfort, Germany, is perhaps the most interesting of those in Europe, because of the high pollution of the river water so used. The river Main, which is used, is badly polluted with sewage and industrial wastes and carries considerable mineral suspended matter. On this account the water is settled and passed through slow sand filters before being applied to the soil to combine with the natural ground water 43 feet below. Less than a hundred feet from the point of its entrance into the soil it was found to contain no B. coli and very few other bacteria.

This plant calls attention to the vital question of the quality of a supply so obtained. The ground at Des Moines and at Frankfort serves as a very fine grained and consequently slow filter, with resulting excellence of the supply. But if the soil be of gravel or course sand, of clay in which shrinkage cracks may open or channels be washed, or seamy rock, the use of this method should not be considered.

Only after the most thorough investigation of the soil at the site in question and its purifying effect should water works authorities adopt this procedure. But where such investigation proves the adaptability of the soil to render a thoroughly safe supply, this method may in many locations afford a comparatively cheap substitute for sand filtration.

Handling Quicksand

Quicksand is a condition and not a material—sand is affected by circumstances that render it "quick" or alive. This is the conclusion of Col. Charles R. Gow, as expressed in an article on "Soil Characteristics" in this issue; and it is that entertained by many others. Some, however, would go further than Col. Gow in attributing the degree of quickness of the sand to certain of its characteristics and adulterants.

Probably all who have had to deal with it, however, and especially contractors for trenches and other excavations, will agree that for pure cussedness and absorption of prospective profits, rock and even hard-pan are only distant competitors. Therefore any facts or suggestions that will aid in handling work involving quicksand are of general interest.

And there seems to be no question that, whatever the effect of the nature of the material on its quickness, it ceases to be quick when water no longer flows upward through it. Therefore any procedure that prevents water under pressure from reaching the sand will thereby destroy its quickness and transform it into just sand. Several methods of effecting this are described by the author.

Some of these methods involve considerable expense, others are very simple. The writer has changed a difficult trenching job into a very simple one by carrying an underdrained trench for a few feet into a quicksand area, sheeting it thoroughly and allowing the area to drain out through it for two or three weeks. But this is applicable only where there is a comparatively small pocket of sand and water. Where the supply of water is continuous and abundant, some method is probably necessary that will intercept

the ground water continuously while the work is in progress. Physical and financial success in handling any given situation depends upon a thorough investigation of conditions and intelligent judgment in selecting the remedy.

Public Improvements by Day Labor

Last month we presented the opinions of two municipal engineers on the subject of constructing public improvements by day labor. Mr. Beck believed that "there is no good reason why a city can not secure organization and equipment equal to that of any contractor, and it must have an advantage in the matter of financing"; but "work of any magnitude can not be effectively and efficiently handled by the ordinary street or sewer department, which is organized with maintenance alone in mind." Mr. Houk concluded that, "as far as municipalities are concerned at the present time, it is only for the comparatively small jobs of ordinary nature, such as the small sewer and paving jobs, which are really maintenance matters and which can be handled by the maintenance crews in connection with their routine work, that force account methods can be considered invariably advisable"; but there are conditions under which other classes of work may sometimes be so.

Opinions are given below of two highway engineers whose experiences with day labor work has not been so favorable. Robert Johnson, county engineer for Marion Co., Tennessee, recently said (in the "Central Constructor"):

"Marion county has tried the day labor system and is through with it. The Board of Supervisors, for the future, will contract this county's work and will pay an inspector to be on the job; this decision is based upon figures carefully compiled during the season of 1923, when an effort was made to determine which of the two methods would produce the best results of construction and produce them at the best price for the taxpayers. The county was divided into halves. Culverts in the southwestern half were constructed by day labor; culverts in the Northeastern half were built by contract. The cost per yard by the day labor system, excluding cost of time purchasing materials and arranging for hauling, inspector's salary, etc., ran $26.95 per cubic yard; the cost under the contract system cost, adding inspector's time, $24.66 per yard, or a saving of $2.29 per yard. If inspector's salary is added to day labor work, it would show a saving by contract of $4.36 per cubic yard. You can readily see what a saving this would be where hundreds of thousands of yards are poured."

F. H. Joyner, for several years highway engineer for Massachusetts and later engineer for the Los Angeles (Calif.) County Highway Commission, reporting to Arizona on road building, said:

"The average man expects an easy job when working for the State; it takes months under good supervision before he can be made to give the State the same service he would have given the constructor on the first day. Politics in some form is ever present in public work, and many men are employed not because of fitness but because of hidden pressure which can not be denied. It is almost certain that day labor work will exceed the constructor's price by more than his profit, and furthermore there is always present the danger that the engineer will close his eyes to defects in his own work, which he would never permit from a constructor. There are examples of that sort in Arizona roads today. From many years of direct supervision of public work, I feel that public bodies face certain fundamental handicaps that make it practically impossible for them to compete with the contractor in either cost or quality, and I unqualifiedly recommend to you contract work."

Contractors' Defaults

The chairman of the National Surety Co., William B. Joyce, speaking recently before the Associated General Contractors on "The Contract Bonding System," attributed the losses to bonding companies from contractors' bonds to the following causes:

50 per cent. to inadequate financial responsibility, and to over-extensions; that is, taking on too much work, and not having the financial ability to pay:

25 per cent. to incompetency;

15 per cent. to dishonesty, and the other

10 per cent. to scattered reasons, such as hard luck, unexpected and difficult situations.

After constructors' defaults, we have found 90 per cent. made unreliable financial reports.

Building Code for New Orleans

The Commission Council of New Orleans in May authorized Frank A. Muth to take in charge the revision of the city building code, which the architects and builders of the city had been urging for some time. Since June 1st good progress has been made, the various committees being at work on the different sections. As soon as each section of the code is drafted by Mr. Muth it is submitted to the appropriate committee, which studies it with a view to making any changes deemed necessary. The aim is to adopt fundamental principles rather than details which sooner or later will become obsolete.

Waterproofing Concrete Standpipe

In our issue of May, 1923, the repairing of the concrete standpipe at Waltham, Mass., was described by George C. Brehm, city engineer and director of public works. In a paper before the New England Waterworks Association October 1, describing this work, Mr. Brehm stated that during the two years that have elapsed since the reservoir was waterproofed and refilled "every indication shows that a complete waterproofing job has been accomplished and no further seepage is visible. The entire outside surface of the reservoir has been thoroughly patched where disintegration has taken place and the whole surface will be given a thin stucco finish for the sake of appearance in the near future."

Information Concerning Eight Activated Sludge Plants

Comparative Data—Plant Design and Operation

From "General Data on the Activated Sludge Process of Sewage Treatment," compiled by the General Filtration Co.

	DESIGN DATA			OPERATION DATA				
	Milwaukee	Indianapolis	Chicago North-Side	Chicago Calumet	Houston North-Side	Pasadena, Cal.	Lodi, Cal.	Gastonia, N. C.
Population Served	575,000	360,000	800,000	.....	100,000	120,000	18,000	10,000
Reduction of Bacteria	90%	.....	.....	.....	.....	98%	h	.....
Reduction of Suspended Matter	95%	95%	.....	68%	.....	99%	h	.....
Stability	72 Hrs.	72 Hrs.	.....	10 Days	.....	10D. 99% +	.....	.....
Type of Plant	Ridge & Furrow	Spiral Cir.	Circulating	Ridge & Furrow	Ridge & Furrow	Ridge & Furrow	.....	Ridge & Furrow
Capacity of Grit Chambers	317 M. G. D.	230 M. G. D.	375 M. G. D.	.....	10 M. G. D.	None	None	None
Capacity of Fine Screens	317 M. G. D.	None	None	None	.....	Dorrco	2.5 M. G. D.	None
C'p'ty of Rapid Sedimentation and Screens	None	72-108 M.G.D.	300 M. G. D.	.....	.....	.....	.....	None
Capacity of Aeration Tanks	85-128 M.G.D.	50-75 M.G.D.	175-262 M.G.D.	3.50 M. G. D.	.....	1.35 M. G. D.	2 M. G. D.	176,000 G. D.
Capacity of Sedimentation Tanks	85-128 M.G.D.	50-75 M.G.D.	175-262 M.G.D.	3.50 M. G. D.	.....	.....	2 M. G. D.	.....
Aeration Tanks—Units								
Number	24	6	36	2	4	18	4	4
Length	263′	952′ (4 Passes)	420′	103½′ 3 Passes	280′	67½′	124′	66′
Width	44′ (2 Passes)	20′ (Each Pass)	34¾′	34½′	18′	10′	11′ 9⅝″	8½′
Depth, Effective	15′	15′	15¼′	14 1/3′	9¾′	15′	15′	10½′
Surface Area per Tank	10,000 Sq. Ft.	19,000 Sq.Ft.	13,750 Sq. Ft.	3,450 Sq. Ft.	.....	675 Sq. Ft.	5,830 Sq. Ft.	561 Sq. Ft.
Rate of Treatment per Acre	15 M.G.D. Min.	20 M. G. D.	15 M. G. D.	22 M. G. D.	22 M. G. D.	.....	15 M. G. D.	.....
Per cent by Volume Activated Sludge	20%	20%	20%	25%	15-25%	25%	20-30%	30-35%
Time of Detention	6 Hrs. Avg.	5 Hrs.	6 Hrs.	4 Hrs.	.....	4 Hrs.	6 Hrs.	4 Hrs.
Tank Capacity per 24-Hour Avg	3,580,500 G. D.	8,333,000 G. D.	4,850,000 G. D.	1.75 M. G. D.	.....	8,100,000 G. D.	655,650 G. D.	750,000 G. D.
Air Per Gallon of Sewage	1.5 Cu.Ft. Max.	0.9 Cu. Ft.	1.0 Cu. Ft.	0.8 Cu. Ft.	1.5 Cu. Ft.	1.0 Cu. Ft.	1 to 2 Cu. Ft.	1.8 to 3.6 Cu. Ft.
Sedimentation Tanks								
Number	11	12	30	2	40	2	2	4
Length	98′ D.	78′	77′	34′	18.8′	50′	30′	30′
Width	.....	42′	77′	34′	10′	50′	30′	8½′
Depth—Effective	* e. 15′	e. 15′	e. f. 13′-16′	e. g. 12.5-15′	22.8′	12′-16′	15′	8′
Surface Area per Tank	8,550 Sq. Ft.	3,000 Sq. Ft.	5,900 Sq. Ft.	1,135 Sq. Ft.	.....	2,500 Sq. Ft.	900 Sq. Ft.	255 Sq. Ft.
Rate per Sq. Ft. Liquid-Surface M'x'm	1600 G.	2070 G.	1600 G.	1550 G.	.....	1500 G.	1450 G.	2400 G.
Capacity each Tank, Maximum	13,680,000 G.D.	6,210,000 G. D.	8,800,000 G. D.	1.75 M. G. D.	.....	262,500 G.	2 M. G. D.	15,300 G.
Maximum Velocity Flow through Tank	1.5 Ft. Per M.	.....	.....	.....	.....	294 Ft. per M.	.35 Ft. per M.	.....
Air Diffusers								
Ratio of Filtros to Surface	25%	7.5%	10%	19%	13 + %	17%	24.4%	20%
Air Pressure	8 to 10 Lbs.	7.5 Lbs.	7 to 8.5 Lbs.	6.6 Lbs.	.....	7½ Lbs.	7½ Lbs.	10 Lbs.
Air Cost per M. G.	a. $5.66	b. $2.64	.....	.....	.....	d. $7.16	.....	.....
Air Cost per M. G.	.....	c. $4.52	.....	.....	.....	.....	.....	.....

a. Includes cost of fuel and labor.
b. Per M.G. with steam turbine compressor.
c. Per M.G. converted for motor operation at 1 cent per K.W.H.
d. Air cost per M.G. at 1 cent per K.W.H.
e. Dorr thickeners.
f. 13′ to top of Hopper. 16′ to bottom of Hopper.
g. 15′ total—12½′ to top of Hopper
h. Variable due to cutting operating costs and experimental work by the State Board of Health.
* Total.

Soil Characteristics in Excavation

Water retention by clays and sands. Caving of trench banks in different materials. Cause of quicksand and methods of preventing quickness in excavations.

In a paper before the Sanitary Section of the Boston Society of Civil Engineers, Col. Charles R. Gow, consulting engineer of that city, discussed at some length the characteristics of quicksand and other soils met with in excavation. The paper has been greatly condensed in the following paragraphs.

Different kinds of soil—clays, sand, gravels, etc.—have general characteristics but also more or less important local peculiarities. Col. Gow's remarks referred especially to the soil characteristics found in eastern Massachusetts.

Sand is practically similar in all respects to gravel except that the particles are finer. Clay particles are much finer than those of sand but generally speaking the distinction between clay and fine sand is the greater plasticity of the former. As clay becomes mixed with sand it becomes less plastic. Pure clays are, generally speaking, practically impervious to water, but porosity increases with the sand content. Sand can usually be drained of water but clay holds it by capillary attraction. Stiff clay taken from the East Boston tunnel when baked in an oven reduced in volume approximately 20%. In the city of Cambridge a large district has settled about 39 inches since the Metropolitan sewer was constructed through it thirty years ago. Every time Massachusetts Avenue is repaved in that locality it needs to be filled up a foot or more. This locality is underlaid with 12 to 15 feet of fill with some mud or peat deposit beneath it, under which is a layer of sand and gravel extending down to clay which lies 20 to 25 feet below the surface and extends to a depth of about 140 feet. The generally accepted theory seems to be that the settlement, which has occurred over the entire area, is due to the squeezing of the water out of this soft clay.

Apparently sand does not settle appreciably on the withdrawal of water, Colonel Gow stating that he had never observed any case of such subsidence unless some of the sand itself was removed with the water. For example, such settlement would be very apparent in the vicinity of driven wells, but no settlement around such wells was on record. This is important in connection with water-tamping trenches filled with sand, in that the water tends to consolidate the sand and the sand does not continue to settle after the water has drained away.

Concerning the ability of vertical walls of trenches in various soils to stand unsupported, Colonel Gow said that of course any granular material which is perfectly loose and free to move will not stand for any appreciable height in a vertical plane. Usually, however, there is some material combined with the granular particles of a soil, either clay or other cementing medium. Natural clays frequently develop tensile strengths of from 100 to 200 pounds per square inch, the strength decreasing with the addition of sand. For any admixture of clay and sand, therefore, the soil will stand as an integral mass until the weight of the vertical mass becomes so great that it exceeds the tensile resistance of the soil.

There is one peculiar characteristic of the caving of trench banks; no matter what the material, when a cave-in occurs due to lack of bracing, the break takes place along the surface at a distance back from the edge of the trench substantially one-half the depth of the excavation. The break generally extends vertically downward from the ground level for a short distance and then curves in toward the bottom of the trench.

In designing trench bracing, it should not be assumed that the material is fluid or semi-fluid in nature, which would produce the heaviest pressures at the bottom of the trench. As a matter of fact, the practice of almost all experienced superintendents is to place the heavier timbering at the top, for they realize from experience that the heaviest pressures are usually found there. It is not at all unusual in the case of trenches in clay soil, where cracking has already taken place and some slight initial movement has occurred, to find it possible to remove some of the sheeting at the bottom of the trench and even to undercut the excavation at that point without causing any further movement. The material that slides into the trench moves as a sort of monolithic wedge with its center of pressure applied approximately one-third the distance down from the surface. This would not hold true for flowing sand or for any soil in a fluid condition. Even under these circumstances, however, the action may be largely local, and if the water can be removed this type of soil readily displays the typical behavior of more stable materials.

The majority of trench accidents are due to an error of judgment in assuming that, because the banks stand up for a short period without lateral support, they will continue to do so indefinitely. Colonel Gow said he was always inclined to be apprehensive concerning a trench that appears to stand without support, for when it does let go, it usually caves suddenly in a large mass and there is little chance for the workmen to escape. Where the soil is a loose, granular material, however, there is generally some preliminary warning in the rattling down of loose materials. He believed it a safe rule to use some bracing for any bank, especially if carried to a considerable depth.

In the case of clay banks, other considerations enter into the problem. The local blue clays stand remarkably well when first excavated, but

when exposed to the atmosphere a short time they air slake and lose their cementing properties, and as the moisture dries out, the bank may fall suddenly. On the other hand, the yellow clays will stand almost indefinitely unless subjected to alternate freezing and thawing. This is because of the presence of iron oxide, the most dependable of the cementing agencies.

An intimate mixture of fine sand with clay will usually stand fairly well if it contains no water, the fine sand seeming to assist in maintaining stability. But when such a soil gives off water, it usually disintegrates somewhat because the sand washes out with the water and leaves voids. Where horizontal sand veins exist in a soil below the ground-water level and a trench carried through them drains out the water, some of the sand will usually come with it and undermine the mass above, causing it to break down.

The tendency of some clays to flow was observed during the construction of the East Boston tunnel. The clay was cut out ahead of the shield perfectly square, with a level roof and vertical sides, often as much as 8 to 10 feet of heading being excavated without any timbering. This was then lined by erecting sets of legs and caps close together, making a solid wall and roof of 8 x 8 timbers. At the end of 48 hours there was usually a noticeable cutting by the legs into the caps until sometimes the cap was cut nearly in two under the pressure. It was also found that the initial settlement on the street surface occurred about 75 feet in advance of the excavation. The clay seemed to flow toward the tunnel heading. This caused a settlement of the buildings along the street of ½ to 1½ inches.

QUICKSAND

Concerning quicksand, Colonel Gow said that after many years of experience he believed it could not be considered as a material but rather as a condition. The readiness with which it flows and becomes unstable is not a natural quality but develops as a natural consequence of an unbalanced head that causes water to flow upward through the sand, which produces a quicksand condition in almost any class of granular material, regardless of the size of its grains. He endorsed the definition of quicksand given by Allan Hazen some years ago: "Quicksand is a sand containing for the time more water than would normally be required to fill its voids and therefore with its grains held a slight distance apart so that they flow upon each other readily." The result is that the degree of instability of sand will be affected by many considerations such as the size and shape of the individual grains and the relative velocity and volume of flow of the water.

Fine sands sometimes display instability under loading because of the presence of a certain admixture of clay which acts as a lubricant to the sand grains. This material should not be confused with that produced by the flowing of water.

A typical combination of underground conditions which produces quicksand behavior involves a substantial depth of fine sand underlaid by a stratum of quartz sand or gravel charged with ground water under a head sufficient to induce an upward pressure in the layer of fine sand above it. The interstices of fine sand are, of course, filled with water up to the ground water level. If now a trench or pit be excavated in the fine sand to a depth below the ground-water level and the in-flowing water is pumped or drained from the excavation, the unbalanced head will induce an upward flow of water through the fine sand into the bottom of the trench, the friction of the rising water lifting the sand grains and causing a condition of instability.

Such a condition frequently causes serious difficulties. If the depth of excavation below ground-water level is considerable, the flow becomes so rapid as to bring with it quantities of sand, thereby raising the bottom of the trench, this sand being replaced by other material flowing in laterally from the surrounding soil and thereby causing a disturbance of the ground on either side of the excavation, sometimes for a considerable distance. The trouble is sometimes avoided by driving a series of well points through the bed of fine sand into the coarse water-bearing stratum and keeping the ground-water level at this point below that of the excavation.

In some instances, however, the coarse water-bearing stratum is entirely missing and the fine sand is merely saturated with the ordinary accumulation of surface water which completely fills its voids. If an excavation is made in this material, using reasonably tight sheeting, the water will be dammed up behind the sheeting higher than the trench bottom and there will be a tendency for it to flow under the sheeting into the excavation. If this pressure is sufficient to cause a flow, sand will be carried with it from behind the sheeting. In such case, the remedy is usually driving the sheeting to a greater depth so as to increase the length the water must travel to enter the trench. In such conditions the engineer will usually find it to his advantage to use tongue-and-groove sheeting.

Colonel Gow expressed the opinion that true sand, no matter how fine or how much water it contained, would make an excellent foundation. During the War he recommended building the foundation for a large structure in sand which, in the excavation for the foundation showed all the qualities of quicksand. A calculated load of 2 tons per square foot on the foundation was decided upon and after six years the building is standing without any evidence of settlement. It should not be overlooked, however, that under such conditions there is danger from the possibility of subsequent undermining; if later operations should permit a flow of the sand from under these foundations, there would undoubtedly be settlement.

In discussing this paper, Edward S. Larned stated that trouble in trenches due to unbalanced head could be prevented by adding weight, immediately following excavation, in the form of screened gravel, cinders, etc., deposited in the bottom of the trench. A material found throughout New England known as "bull-liver," when first exposed, is very firm and will withstand a considerable quiet load; but the slightest agitation, as for instance the movement of the men's feet working on this bottom, will cause it to become "quick," and in that condition it is impossible for men to work in it. By the use of a suspended platform (not touching the bottom) men have been enabled to excavate without disturbing the bottom; and then by adding weight in the form of graded coarse material, a later upward movement of the material has been prevented. This sort of material is most difficult to drain by any ordinary system of bleeding or pumping.

Leonard Metcalf told of streams in Porto Rico, the outlets of which into the ocean were closed by sand barriers thrown up by wave action, which retained the stream behind them for some hours until it finally escaped by boiling up through the beach below the barrier, making the sand "quick" for a time, although just previous it was hard enough to drive over. He knew of one case where a horse and wagon and several occupants, driving over such a spot at the critical time, were all engulfed.

Preparation of Filter Sand*

By W. M. Weigel†

Sources of supply of sand for water filters, methods of excavating, preparing and shipping, and prices.

SOURCES OF SUPPLY

Compared with building sand, the production of filter sand is small and requires more careful preparation and extensive plant. A much better price is obtained than for the ordinary grades of sand, and in consequence the points of production are more widely scattered and the sand is sometimes shipped long distances.

The chief producers are in New Jersey, North Carolina, Illinois, Minnesota and Missouri, but any good sand bed can produce suitable filter sand, if it can be washed clean and contains enough grains of the required size to warrant their separation from the rest of the sand. Where the coarser grades of sand-blast sand are produced, the finer material is often prepared for filter sand. Also, the finer grades of sand-blast sand may be used for filter sand if prepared with proper uniformity.

METHODS OF MINING

Filter sand may be prepared from ocean beaches, lake deposits, river bars, sand banks and soft sandstone, and the method of excavation depends largely on the nature of the deposit.

Where beach sand is used, the excavation is above high tide, so floating dredges are not feasible. Also, the area excavated usually has considerable horizontal extent so that excavating machines are best mounted on railroad track paralleling the direction of the beach. Locomotive cranes with clamshell buckets make about the most efficient equipment; they have a wide reach and are more suited to the comparatively shallow excavations than steam shovels. The sand is conveyed to the washing and screening plant, preferably in side dump cars drawn by steam or gasoline locomotive.

Sand in lake shores and bottoms and river bars is commonly excavated with dredging pumps mounted on barges; they give very mobile, efficient units. Sand can be pumped from any desired part of the bed, and enough water is at the same time pumped for washing, or at least most of the washing. The mixture of sand and water is also conveyed to the plant through pipe lines in the same operation, within reasonable distances, and the action of the pump impellers tends to break up any clay lumps and facilitate washing. If the sand is to be conveyed some distance in cars clamshell dredges sitting on the bank of the lake and loading into cars alongside, are sometimes used, as the power cost is less than for a dredge pump.

When an artificial pond can be maintained, floating dredges are often the most efficient means of excavating the sand from what would otherwise be dry banks. If stripping of overburden is necessary, it is done by hand, scrapers, or steam shovel, and the overburden hauled away in wagons or motor trucks. Sometimes, the overburden is back-filled into the excavation. The floating dredges have steam, electric or oil engines, depending on which form of power is cheapest and best suited to the conditions.

Dry sand banks are mined with steam shovels if the plant capacity is sufficient to warrant their use, otherwise the cars or wagons are loaded by hand. Practically all regular producers of filter sand, however, have operations large enough to warrant the use of mechanical excavators.

Soft, friable sandstone constitutes most of the source of filter sand in the Mississippi Valley district. This sand is characterized by uniformly rounded grains, in this way differing from the angular to irregular surfaced grains from lakes and banks. Some river sand also is mined in this territory.*

The excavation of sandstone for sand has been briefly described by the writer in Bureau of Mines Serial No. 2615, "Sand Blast Sand."

*From a report of the Bureau of Mines, Department of the Interior, entitled "Filter Sand for Municipal Water Supply."

†Mineral Technologist, Bureau of Mines, Department of the Interior.

*Dake, C. L., Sand and Gravel Resources of Missouri, Mo. Bureau of Geol. and Mines, Vol. XV., 2nd Series, p. 78.

PREPARATION

Preparation of filter sand involves washing or screening and usually a combination of both. Very few sands are clean enough without washing. These processes have been outlined in the report on Sand Blast Sand mentioned above, as some firms produce both sand blast and filter sand from the same bed or bank.

For filter sand, the specification as to size and uniformity is rigid, so that careful screening or sizing is essential. In some instances, the sand is re-screened to insure the removal of fines.

Sizing by screens is almost universal, but where an ample water supply is available, it would seem that hydraulic classification should give a suitable product, as all grains are of the same specific gravity and roughly, of the same shape. It is admitted that more careful supervision would be needed than in sizing by screens, but that should be more than offset by lower first cost or greater capacity, and the washing and sizing would be performed in one operation. The sand originally used for the Washington, D. C., filtration plant was prepared by combined screening and hydraulic classification.†

The sand bank used contained considerable clay in the form of lumps and seams that could not be rejected in mining, making removal of the clay necessary. The sand from the bank was first dumped through a coarse grating to remove the larger clay lumps. This was followed by a revolving screen with 2-inch openings. The sand then passed through a revolving screen with 4 mm. openings in which jets of water played. The water and solids passing through this screen flowed to pug mills, which broke up and pulverized the remaining clay lumps. An excess of water here overflowed and removed a good portion of the day. The sand was drawn out near the bottom. The pug mill was followed by the washers, which were long boxes with sloping bottoms, the feed entering at the shallow end. Water supply pipes near the bottom had perforations pointing downward. The overflow of clay and water was removed by a central trough. The sand, after being separated from the clay by the combined horizontal and upward currents of water, was drawn off at the bottom of the deeper end of the washer. The capacity was stated to be about 1 cubic yard per hour per square foot of box area.

SHIPMENT AND PRICES

Shipment is usually made in carload lots in box cars. Considerable business is, however, done in less than carloads to small filtration plants to make up losses due to re-washing of the filters. In this case the sand is shipped in bags.

Prices vary widely. In small lots in bags, prices $10 to $12 per ton, f.o.b. shipping point, have been recently quoted. In car lots in bulk, the price range is from $4,00 to $8.00 per ton, f.o.b. shipping point, depending on location and

†Hazen, Allen, and Hardy, E. D., Water Filtration at Washington, D. C., Trans. Am. Soc. Civil Eng., Vol. LVII., p. 326.

A Municipal Super-Power System

A system of inter-connected power lines has been formed in the Northwest by several municipalities for mutual benefit. Seattle and Tacoma tied their transmisison lines together in 1923 with a 60,000 volt transmisison line. Seattle's line begins near the Canadian boundary and extends for 100 miles to that city, passing near six cities. The tie line to Tacoma is 34 miles long and passes two cities. The city of Aberdeen is building a hydro plant and will connect onto the Tacoma line and furnish current to the cities of the Grays Harbor country.

This inter-connected system at the beginning of this year supplied current to 108,000 consumers for light, power and heat, and the capacity of the existing and contemplated hydro and steam plants totals about one million horsepower.

Expenditures by California Municipalities

The 1923 report of the State Controller of California contains more than 200 pages of solid figures which do not of themselves make very interesting reading but from which a number of interesting facts can be learned concerning the expenditures last year of the 264 municipalities of the State.

The first table brings out prominently the rapid increase in municipal expenditures. In 1912, the first year referred to, the municipal payments by all the municipalities of the State totalled 53¼ million dollars, and by 1923 these had increased to 142¼ million dollars, or more than 2½ times. Moreover, the increase from 1922 to 1923 was nearly 20%. The increase was due principally to increases in expenditures for public service enterprises, protection to person and property, general government, highways and interest.

The expenditures of the cities are classified under thirteen different heads. These show that the payments for public service enterprises led with $53,700,000, protection to person and property (mostly police and fire departments) being second with $19,000,000, highways third with $13,400,000, interest fourth with $9,000,000 and education fifth with only $4,000 less. (The amounts are given to the nearest $100,000 only, as this makes comparison easier than if a long string of figures be given in each case.)

Of the two protection departments, the payments for the police department exceeded those for the fire department by a little over $100,000—in other words, the two were nearly equal.

Sanitation and promotion of cleanliness was maintained at a total cost for all municipalities of $5,800,000, of which $3,000,000 was for refuse collection and disposal, $1,400,000 for sewage disposal, $1,200,000 for outlays (construction work, etc.), and $57,500 for sanitary instruction.

There were 141 municipally owned waterworks plants in the State, and their total receipts (other than from sale of bonds) amounted to $12,500,000. Of the expenditures, which totalled about

$5,000,000, the largest item was plant operation and maintenance $3,350,000; the next largest was administration and collection expenses, $1,200,000; the balance being for water purchased and other ordinary expenses. In addition, they paid out $2,300,000 for bond interest and redemption and $6,700,000 for outlays.

Other data given include the number of consumers, total consumption, source of supply, cost of the system, miles of mains, etc. The rates per thousand gallons vary from a maximum of $1.25 to a minimum of 3½ cents. Of the three cities charging $1.25, Santa Ana and Orange pump water and derive it from wells, while Chino uses well water, but obtains it by gravity. Only one municipality has a rate as low as 3½ cents, this being Arcadia, which also derives its water from wells and pumps it. However, the minimum meter rate per month for Arcadia is $1.25, while Orange, with a rate of $1.25 per thousand gallons has a monthly minimum of $1.

Twenty-three municipalities own their electric light plants, and their receipts from the sale of commercial light and power totalled $9,300,000, while the cities were charged $800,000 for light and power furnished, eight of the plants making no charge for this municipal service. The payments by these plants totalled $3,000,000 for operation and maintenance of plant and system, $1,000,000 for administration and collection, $700,000 for purchase of current. They paid out $1,800,000 for interest and redemption of bonds and 3¼ million for capital investments.

Of the property owned by the municipalities, by far the greatest value was in the municipal service enterprises, which were valued at $210,500,000. Next came the parks at $70,600,000, city halls at $19,600,000, fire departments at $17,200,000, libraries $9,500,000, highway department equipment $4,000,000 and police department $2,600,000.

St. Louis Turbine Pumps

The pumping equipment at the Chain of Rocks Station of the St. Louis Waterworks includes three turbine-driven centrifugal pumps, two of 40 m.g.d. capacity and one of 110 m.g.d. capacity. The last is of the multi-stage impulse type consisting of a series of 13 wheels, each running in a separate compartment. After four years' service of this pump, tests showed that the original capacity had dropped considerable, as had the duty figured on B.t.u. basis. The water end was completely overhauled, but this did not appreciably increase the capacity or duty. Further tests indicated that the steam end was choked and that this was the cause of a reduction of the original duty of 123 million-foot-pounds to less than 95 million.

In an effort to remedy this condition, about a barrel of coal oil was pumped in at the throttle as the turbine was being shut down, but this had little effect. The steam end was then completely dismantled and the trouble was apparent. An examination of the rotor showed that about one-half of the buckets in the wheels and one-half of the guide vanes in the diaphragms were clogged with scale. There were also evidences of cutting action due to the erosive action of solid matter carried in the steam. Analysis of the scale showed 21% oil, which undoubtedly aggravated the accumulation of scale by building up a sticky carbonaceous mass. It appeared to be evident that the scale-forming material, possibly boiler compound, together with the oil, had been carried over from the boiler in the steam. The wheels which required reblading were sent away for the purpose and the others were satisfactorily cleaned with a sand blast. After these repairs a test showed that the full capacity of the turbine had been restored and the duty was nearly that obtained in the acceptance test.

Municipal Street Cleaning in Philadelphia*

The new incinerator—Organization—Cost of service—Attitude of citizens—Recommendations by the Bureau of Municipal Research.

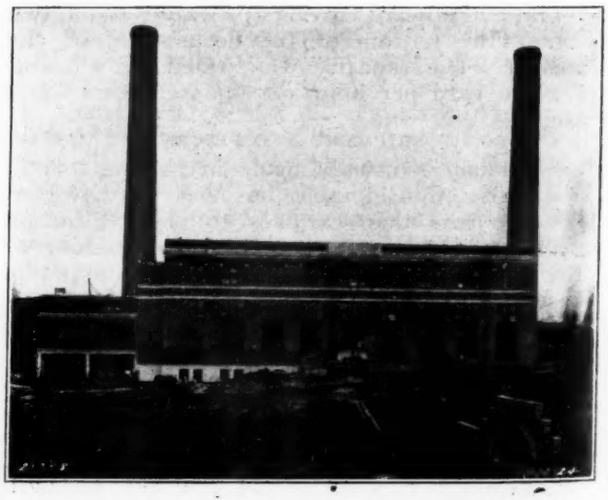
By Charles A. Howland

THE HARROWGATE INCINERATOR

The city recently put in service an incinerator constructed to consume both rubbish and garbage. It is a Sterling-type, high-temperature plant consisting of four furnaces of four cells each with a total capacity of 280 tons of mixed refuse per 24 hours. The plant, which has cost slightly over $400,000, is built into a hill so that wagons enter the tipping floor from the ground. Refuse is dumped over the edge of the tipping floor onto the charging floor 12 feet below, where it is pushed by hand through the charging doors. No fuel is used other than refuse.

Containers, controlled by pneumatic ma-

*Concluded from page 302.



INCINERATOR PLANT DURING CONSTRUCTION.

TABLE 1—HARROWGATE INCINERATOR
Garbage and Refuse Test, Furnaces Nos. 1 and 2, June 4, 1924

WEATHER—Fair

Garbage incinerated	31.27 Tons	Weighed 6/3/24	Condition—Good
Refuse "	13.64 "	" 6/3/24	" "
Total "	44.91 "		
Ratio: Garbage 69.6%	Rubbish 30.4%	Guarantee G—65%	R—35%
First Charge 8:15 A. M.	Last charge: 12:15 P. M.	Charging time—4 hours	
Complete combustion	Furnace No. 1: 2:30 P. M.	Furnace No. 2—2:00 P. M.	

	Furnace No. 1	Furnace No. 2
Av. Pyrometer	1743°	1700°
Av. Temp. preheated air	339°	334°
Av. Velocity forced draft	4.0"	4.3"
Av. Temp. stack	711°	
Cleanings	1	2
Ash removed from grate	7.38 Tons	Total ash 7.70 Tons
" " " flue	640.0 Lbs.	

Observers—Wells, Rhinehardt—Temperatures
Wells, Reilly, —Weights
Dugan —Ash
Hunter —Charges

TABLE 2—HARROWGATE INCINERATOR
Garbage and Refuse Test, Furnaces Nos. 3 and 4, June 10, 1924

WEATHER—Fair

Garbage incinerated	36.61 Tons	Weighed 6/9/24	Condition—Good
Refuse "	17.21 "	" 6/9/24	" —Fair
Total "	53.82 "		
Ratio: Garbage 68.0%	Rubbish 32.0%	Guarantee G—65%	R—35%
First Charge 8:20 A. M.	Last charge 1:20 P. M.	Charging time—5 hours	
Complete combustion	Furnace No. 3: 2:20 P. M.	Furnace No. 4—2:20 P. M.	
Lower damper on No. 4 broke 8:30 A. M.			

	Furnace No. 3	Furnace No. 4
Av. Pyrometer	1642.5°	1617.5°
Av. Temp. preheated air	353°	322°
Av. Velocity forced draft	4.0"	4.24"
Av. Temp. stack	750°	
Cleanings	1	2
Ash removed from grate	8.64 Tons	Total ash 8.83 tons
" " " flue	380 Lbs.	

Observers:
Wells, Rhinehardt—Temperatures.
Reilly—Weights.
Dugan—Ash.
Hunter—Charges.

chinery, discharge the refuse into the cells. The clinker is raked through clinker doors into chutes in the stoking floor. Dump cars of 1½ cubic yards capacity receive the clinker in the ash tunnel beneath and convey it to bins, from which it is raised by elevator for final removal. Forced draft through regenerators for pre-heating is used. An exhaust fan draws air from hoods over the clinker doors and from points under the edge of the tipping floor. The building is of brick on concrete foundations and includes a superintendent's office, store room, and scale house.

INTERIOR OF INCINERATOR DURING CONSTRUCTION.

At the present time a superintendent, timekeeper, two ash wagon drivers, watchman and 50 laborers of various grades are employed at the plant. The payroll for one week is about $1,411.24 and, during a recent week, the refuse consumed consisted of 615 tons of rubbish and 346 tons of garbage, a total of 961 tons of mixed refuse. These figures give a net labor cost of $1.47 per ton of mixed refuse burned. Tables 1 and 2 give data of the results of

operation of the four furnaces, but as the plant has been in operation only a short time the results of the operation should not be taken as conclusive.

ORGANIZATION

One of the major problems in rendering efficient street-cleaning service is that of securing and maintaining a high level of competence and morale in the organization of approximately 3,000 officials and employes. The city's handling of the street-cleaning employment situation has been, in the main, in accordance with good practice. By placing the entire labor force, as well as the supervisory and office organization, under civil-service control, the city has assured itself of reasonable standards of fitness. The civil service commission has exercised its control with moderation, and has made commendable efforts to facilitate the recruiting of laborers. With a few exceptions, the working conditions in the street-cleaning division are as favorable as may be found in the average private or public service, and are conducive to good morale rather than depressing.

In certain respects, however, there have been shortcomings. Perhaps the most serious of these is the inadequate wage scale now in effect. No doubt the high turnover in the labor force, which in 1923 was approximately 58 per cent, is largely due to the low wages paid by the city. The hours of work for skilled and unskilled laborers, especially for the latter, seem unnecessarily long and exacting. This condition, too, may have something to do with the high labor turnover.

COST OF SERVICE

While service, rather than cost, has been the criterion by which the results of municipal street-cleaning operations have been judged, cost is, of course, an important consideration. The analysis of finances, given in some detail in the report of the Bureau of Municipal Research, shows that, under contract operation in 1920, the cost of street cleaning was $5,160,874.22. In 1921, when the city was cleaning two districts and the contractors eleven, the cost was $6,071,217.21 for the whole service; while, under city-wide municipal operation in 1922, the cost totaled $5,140,615.27. When reasonable allowances are made, such as for changes in price levels, it can be estimated that contract work would have cost approximately $5,264,000 in 1922, or $123,400 more than municipal work. These figures show an actual saving of money by city operation.

ATTITUDE OF THE CITIZENS

It has not been possible to obtain the universal cooperation of citizens in the refuse-collection work. This has been due in part to the inadequacy of existing laws and ordinances for the regulation of the preparation of refuse for collection, and to the difficulty of enforcing them. An effort was made in 1922 to inform the public of the requirements and to educate them in proper methods, but inadequate facilities for this work have prevented the continuance of the educational campaign in as effectual a manner as desired. A squad of inspectors is maintained to furnish information, one of them being detailed for this purpose to the public and parochial schools. Addresses are delivered before civic and business bodies when requests are received.

The householder, in Philadelphia, is often placed under a serious handicap. Prevailing types of house construction do not facilitate easy removal of refuse from the premises. When refuse is placed at the curb the numerous scavengers scatter it about. The elimination of the scavenger would do much to improve conditions on the streets.

RECOMMENDATIONS BY THE BUREAU

The Bureau of Municipal Research concludes, in the light of its study, that the change to municipal operation was accomplished in a creditable manner and that the subsequent performance of the city has been commendable. It has not been possible, however, to overcome all difficulties nor to perfect the processes in the short period of municipal operation. The major recommendations for the improvement of the service include a detailed study by specialists and the provision of adequate funds to effect the necessary improvements. Changes in the general organization of the division and a more adequate staff personnel, especially engineers and an educational supervisor, are suggested. Among the changes in conditions of employment is recommended an increase in rates of compensation for labor and better uniforming of the street forces. A continuous educational and law-enforcement campaign is advised. The improvements recommended also include the keeping of more complete financial records, and better control of plant and equipment.

Supplementing Mr. Howland's article, we present below additional items abstracted from the report of the Bureau.

HORSE-DRAWN EQUIPMENT CLEANING STREETS

Philadelphia purchased 1,600 head of livestock in 1921 and became the largest single owner and user of horses in the city. The purchase of horses instead of automobile apparatus is defended by the statement that "for street work, where frequent starting and stopping is necessary, the horse-drawn vehicle is superior in many ways to the gasoline motor vehicle and possibly in some ways to the electric motor vehicle. The horse, moreover, is thoroughly reliable, and there is less interruption to horse-drawn service than to motor service."

GARBAGE WAGONS

Most of the garbage wagons used by the city are of steel bodies covered with hinged iron lids. These lids are subject to unusual wear and tear and rattle objectionably. The department has conducted experiments with waterproof brown canvas covers, especially made to stand hard service, and the results proved satisfactory except in freezing weather. These covers can be drawn down tightly to prevent spilling even when the wagons are overloaded. Since

overloading is the general practice, the canvas cover is more desirable than the iron cover, which stands partly open, revealing the load.

BLOCK MEN OR WHITE WINGS

It is impossible to build a machine that has the intelligence of a workman. The hand-broom sweeper can do well certain kinds of cleaning that a machine cannot do at all. The so-called alleys must be cleaned by hand labor, and on streets with numerous depressions or irregular gutters, hand-brooming alone is effective. If he cleans only the gutters and the scattered accumulations of dirt on the crown of the street the block man is capable of covering a considerable territory in a day's work. Automobile traffic throws the dirt from the street into the gutter, and in many localities all that needs to be done to make a street attractive is to clean the gutters and pick up the litter. In districts with well-paved streets, cleaning by block men is very effective if supplemented by flushing. As a result of a detailed study of methods, the officials of the Street-Cleaning Division are of the opinion that the number of block men will be further increased very considerably during the next few years.

Mechanical Tamper on Concrete Streets

The village of Bedford, Ohio, near Cleveland, has undertaken a good sized program of street construction, and is building a considerable yardage of concrete pavements, an interesting feature of which is that the specifications provide that the concrete be spread and tamped mechanically.

A cross-section of the pavement is shown here. On some of the construction a concrete curb is placed instead of the stone curb shown, but in any event, the finishing machine for spreading and tamping must travel on the curbs instead of the steel side forms used for rails on ordinary highway construction.

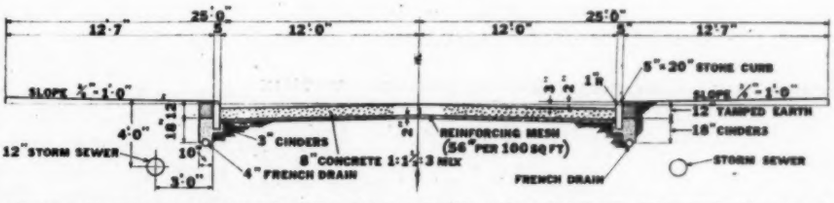
The method of using the finisher is shown by the photograph. Steel plates, bent to an angle shape, were laid along the top of the curb to protect it. Four such plates, each about ten feet long, were used on each side of the pavement. These are taken up and relaid as the machine advances.

The strike-off and tamper of the machine were fitted with extensions, so that they would operate at the required distance below the tops of the curbs.

As it was not possible to use the regular finishing belt of the machine, because the curbs did not allow clearance, the final floating of the surface was done with a wood float, extending the full width of the pavement and provided with plow handles on each end. After the mechanical finisher had spread and tamped the slab, one or two trips over with the wood float completed the job.

It is believed that this will give a slab of greater density, in that the tamping will drive our air and water voids.

B. T. Wright, village engineer, is in charge of the work.



CROSS-SECTION OF CONCRETE PAVEMENT AND STREET APPURTENANCES.

MECHANICAL TAMPER ON STREET PAVING.

Fire Services at Hudson, Massachusetts

We have received from the superintendent of the Department of Public Works of Hudson, Mass., A. M. Custance, a copy of the rules and regulations for fire services adopted by the commissioners of public works this year. These provide that fire service connections are to be made by the commissioners to the street line at the expense of the applicant, who will be charged the actual cost plus 10 per cent. for supervision and inspection. It is provided that no new fire service connections will be made to any system having any connection with any water supply other than the public water supply; but where water from other sources is to be used, the system must be entirely separate from that connected with the public distribution sysem. Where a fire service now in use includes a fire pump connected with sources of supply other than the public water supply of Hudson, the two supplies shall be separated by means of double check valves located in a masonry vault, subject to the approval of the commissioners.

In the case of repairs made by the Department on the premises of a domestic consumer, or where meters are frozen or damaged, the consumer will be billed the cost of the work plus 5 per cent.

Dirt in the Atmosphere

The First National Bank of Boston has completed a new building which contains "all the modern improvements," including an air-washing system by which water spray washes 200,000 cubic feet of air per minute. The air is taken through intakes located 30 feet above the street, but in spite of this there is removed from it five pails of soot, dust and other solids per day. And Boston's air is not considered specially dirty.

Recent Legal Decisions

PAYMENT BY CITY OF SURCHARGE FOR ELECTRICAL CURRENT NOT CONSENT TO INCREASED RATE

The Nebraska Supreme Court holds, State ex rel. City of Chadron v. Intermountain Ry. Light & Power Co., 194 N. W. 793, that a court may compel by mandamus the performance of a public duty assumed by a public service corporation in furnishing electrical current to a municipality and its beneficiaries, when from the franchise contract it appears that such duty is plain and unequivocal. And the payment of a surcharge of 33 1/3 per cent. in addition to the maximum contract rate by the city of Chadron and its inhabitants under threat of shutting off the electrical current unless the increased rate was paid, was held not to be a consent to such increased rate or a change of the contract between the city and the public service corporation.

CITY'S FUNDS MUST BE EXPENDED FOR PUBLIC PURPOSE

"Public funds can only be expended for public purposes, and the courts must determine whether a given expenditure is for such a purpose, and will enjoin it at the suit of a taxpayer if it is not. It is well settled that, if the primary object of an expenditure of municipal funds is to subserve a public purpose, it may also involve as an incident an expenditure which, standing alone, would not be lawful. It is equally well settled that, if the primary object is to promote some private end, the expenditure is illegal, although it may incidentally serve some public purpose also. The courts as a rule have attempted no judicial definition of a public as distinguished from a private purpose, but have left each case to be determined by its own peculiar circumstances." Applying these principles, the Minnesota Supreme Court, Burns v. Essling, 194 N. W. 404, affirmed a judgment enjoining a city from pledging its credit or expending its funds to aid in the construction of a hockey rink.

FEED FOR SUBCONTRACTOR'S HORSES WITHIN HIGHWAY CONTRACTOR'S BOND

The Indiana Appellate Court holds, Federal Paving Co. v. Raschka, 141 N. E. 644, that feed furnished a subcontractor for his horses used in the construction work of a highway is material furnished to carry on the contract within the contractor's bond required by the Indiana Highway Construction Act.

COUNTY COMMISSIONER NOT DISQUALIFIED BY OWNING REAL ESTATE WITHIN ASSESSMENT AREA

The Ohio Supreme Court holds, Hamilton v. Board of Comrs., 108 Ohio St. 566, 141 N. E. 684, that the fact that a county commissioner owns real estate within the assessable area of an improvement to be taxed by a special assessment for the construction of a road does not of itself disqualify him to act as a county commissioner in proceedings relative to laying out and making a road under section 6906 et seq. Ohio General Code.

PAVING ORDINANCE MAY INVITE BIDS ON SEVERAL KINDS OF PAVING MATERIALS

The Illinois Supreme Court holds, City of Olney v. Baker, 310 Ill. 433, 141 N. E. 750, that an ordinance is not invalid because it provides for the improvement by paving with one of four kinds of material, namely, asphaltic stone, asphaltic cement, plain asphalt or brick; and that the kind of material to be used was to be determined by the city council after bids had been received. The court said: "We know of no authority which prevents bids being received on several kinds of paving work where the purpose for so doing is to bring about fair and really effective competition among bidders for the construction of the improvement contemplated."

IRON PIPE UNDER HIGHWAY NOT A CULVERT UNDER STATUTE REQUIRING GUARD RAILS

A board of county commissioners constructed a highway 24 feet wide, with a 14-foot paved brick road in the centre. At the bottom of the embankment it inserted a 12-inch corrugated iron pipe, 44 feet long. This pipe was 13 feet below the surface level of the traveled highway and the ends thereof 10 feet distant therefrom. In an action against the board of county commissioners for damages for injuries to an automobilist whose car skidded on the icy highway and went over the declivity the Ohio Supreme Court held, Riley v. McNicol, 141 N. E. 832, that the pipe was not a "culvert" within the meaning of section 7563, Ohio General Code, and the board was not liable for failure to erect and maintain guard rails at a point on the highway above the pipe, or on the side of an approach thereto.

CONTRACTOR'S DAMAGES FOR BREACH OF ROAD CONTRACT

The Circuit Court of Appeals, Eighth Circuit, holds, A. R. Young Const. Co. v. Road Improvement District, No. 2, that, where a road contractor was justified in abandoning the work he was entitled to the anticipated profits which he could establish by proper evidence, and the expenses necessarily incurred in preparing for further performance of the contract, but not for expenses incurred in retaining employees and machinery, etc., after the abandonment in anticipation of resumption of work.

It was held error to charge the contractor with a sum for defective work where the work had been approved by the district's engineer, whose decision as to material and construction was declared by the contract to be final and conclusive, there being no claim that the engineer did not act honestly.

The contractor was not liable to a subcontractor for his loss of anticipated profits, the district, which had breached the contract, being liable therefor.